PAVING AND MUNICIPAL ENGINEERING

A Journal Devoted Specially to Street and Sidewalk Paving, Sewerage, Water-Works Construction, Street Lighting, and all Matters Pertaining to Municipal Engineering.

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Articles relating to the different branches of municipal engineering are desired. Stamps should accompany manuscripts for return postage if unavailable.

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The columns of this publication are open to the discussion of all subjects relating to paving, sewerage, water-works, street-lighting, and the physical improvement of cities. Practical information as to the merits of materials used in such work and new methods, with photographs and drawings, which may be used for illustration, are especially desired. We are glad to get brief notes as to proposed improvements and the letting of large contracts.

City engineers are requested to send us as early as possible copies of their annual reports, which will be given proper notice.

Articles relating to methods of road making and maintenance are invited.

PAVING-BRICK CLAYS.

By W. A. Eudaly.

"IT can't be done!" These were the words of a prominent citizen of Scranton, Pennsylvania, the other day, when the statement was made in his hearing that No. 1 street-paving brick could be made from soapstone and shale, such as is found in abundance in and about Scranton.

"It is impossible to make brick from such material," quoth he, with a shake of the head.

"But, Mr. ——, it is being done every day. Millions of the best brick of the land are being turned out every month from such materials."

"I would have to see it done to believe it;" and with a shake of the head and a significant wave of the hand he escaped.

This was too much for the enterprising citizen who chanced to overhear the above conversation. And Scranton will, no doubt, in the near future have a large paving-brick plant. The clays are now being tested, that a selection may be made from the great variety found both above and below the coal measures.

Scranton certainly possesses every natural advantage for a good street paving brick plant. They have the clay in abundance, and millions of tons of slack coal from her numerous mines. She is a growing city with a population of about 100,000, and with but very few thoroughly improved streets. To add to the natural advantages (if bad streets are natural), Scranton has an abundance of capital, and just now the paving spirit is at flood tide. We predict in the near future that she will add to her already numerous industries the manufacturing of street paving brick in large quantities.

* * * * * * * *

One can hardly realize that after so much has been written and said on the subject of manufacturing street paving brick, that any intelligent business man could be found who had not heard of the millions of paving brick that are turned out annually from the shale and soapstone formations. Many of the largest and best plants are working these materials exclusively.

I have often been asked to describe the physical appearance of paving brick clays, leaving out all chemical terms. This I am unable to do. I might, however, give a fair idea of the appearance of some of the clays that are now being successfully made into street brick.

At Galesburg, Illinois (one of the noted paving brick centers), the clay is known as soapstone; it lies near the surface of the bluffs, or hills, in depth from fifty to two hundred feet.

After the small amount of stripping is taken off the sides of the hill or clay bank resembles somewhat large layers of grey limestone, except perhaps it is a lighter color.

The clay is almost free from grit. When pulverized and moistened it is sticky or doughy in the fingers. A lump taken fresh from the bank without crushing or drying takes water very slowly, and if rubbed on a smooth surface before drying will present a slick, glassy or oily surface.

At Moberly, Mo., the clays also lie in the hills or bluffs, but have somewhat more surface soil or stripping. The clay in the bank seems to be more dense than the Galesburg clay, and when freshly exposed presents a dark steel color. It does not break in regular fractures like the Galesburg clay, but is more inclined to split. This clay differs from most all other clays of this nature, in this, that the miner setting off a charge of giant powder often finds, in the huge layers thrown out, large imprints of ferns and other vegetations of the carboniferous age. I saw at the bank an imprint of a stock of what is commonly known as cain, at least six inches in diameter, and several feet long. This clay is very difficult to crush and soak. It has the oily appearance when rubbed and a smooth surface, but not quite to the extent of the Galesburg clay.

The Diamond Brick Company, of Kansas City, Missouri, has a very similar clay to the clays above described except that it is found very far below the surface in the hill-side, in fact it is from fifty to two hundred feet below the surface, and is therefore mined by driving entries and drifts the same as mining coal.

The texture of this clay is very fine. It is almost free from grit and can be polished with a smooth service when taken fresh from the bank. In the green state, or fresh from the bank, it is not so dark in color as the Moberly clay, but darker than that found at Galesburg.

The clay at Atchison, Kansas, is also classed among the soapstone clays, and is very similar to the three above mentioned except that it runs from a light gray to a dark gray in the bank. It also has a slight trace of sand or grit and does not polish quite so smooth when green. It vitrifies at a high degree of heat and stands up well under fire.

At Sioux City, Iowa, the clay is also found in very high bluffs. Viewed from a distance, it resembles more the appearance of large or thick layers of stone than either of the former clays. The physical appearance of these clays is different from all other clays that I have seen. In its natural state it is very hard and dense. Has quite a per cent. of sand, also streaks of a semi-fire-clay. The clay, when dry, becomes very hard, it does not have so much of the oily or soapy appearance. It requires very heavy machinery to handle it properly, and is one of the hardest clays to burn I have seen. It stands well under the fire and makes a very superior paving brick.

The clay at Des Moines, Iowa, is very similar to the Sioux City clay in this, that it possesses quite a per cent. of sand and fire clay. I do not wish to convey the idea that the sand and fire-clay are mixed or in the same vein, for they are not, neither at Des Moines or Sioux City, but at both places the clay bank is very high, having a working face of from fifty to one hundred feet, and in both the sand, clay, and semi-fire-clay lie in pockets and different layers.

The Des Moines clay is more plastic in the natural state than any other similar clays; in fact it is found almost soft in portions of the bank, while in other portions it is quite hard and dense. This clay also requires a very high degree of heat, and stands up well in the kiln, and produces among the best paving brick in the market.

Before passing, I would say that neither the Des Moines nor the Sioux City clays polish in the green state so readily to a smooth surface, and when burned do not break with quite so smooth or glassy a fracture as some other clays.

At Middleport, Ohio, Garrett & McManigal are manufacturing excellent paving brick from a deposit made at some time, no doubt, by the Ohio river. This clay is plastic in the bank, has no resemblance whatever to soapstone or shale, is taken out of a flat field near the surface. It has very little sand. When soaked, becomes sticky and tough to the touch, shrinks considerable in burning, but stands up well under fire. Most brick men would pronounce this a number one red brick clay; in fact, the company was largely engaged in making dry-pressed brick before going into the paving-brick business.

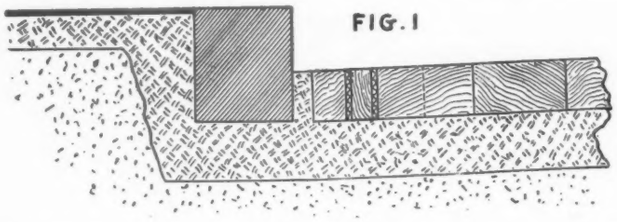
At Westerville, Ohio, Mr. J. W. Emerald is making paving brick from a clay which in appearance seems to be nothing more or less than a surface clay. I do not mean soil. The clay is very dark, almost black. It is very plastic and can be handled easily with the spade, almost free from sand. This is a remarkable clay, one that few would ever suspect as suitable for paving brick, but teaches that paving brick material can be found in the swamps and marshes as well as in the hills and bluffs.

Perhaps I have made this contribution already long enough, but there are many clays and clay fields yet to describe, which might aid others to some extent in judging of their clays, from the physical appearance only. I shall take up the subject again soon.

PAVEMENTS IN PARIS.

By Louis H. Gibson.

HEREWITH I send drawings of curbing, gutter, sidewalk, etc., of Boulevard St. Germain, for the purpose of illustrating certain details of the construction connected with wooden pavements in Paris. Fig. 1 is a section and Fig. 2 is a plan. The curbing is 12x14 inches, and is of granite. It rests on concrete at the base, and on the sides there is a concrete filling, so that the concrete under the sidewalk need not come to the bottom of the street concrete, excepting next to the curb. This pavement has been down, I understand, some seven years, and is in good condition. During several days past I have been interested in watching some repairs which have been making in the gutters. They did not seem to be in a serious condition, nor is it the policy of the organization here



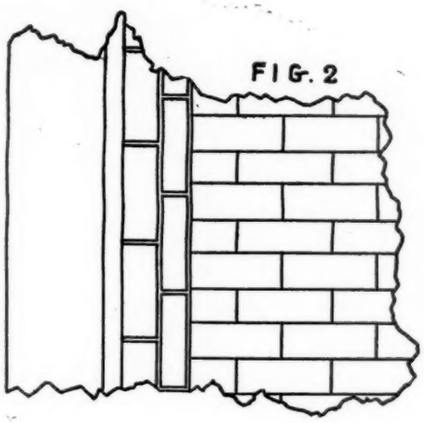
that they ever should be. The slightest evidence of failure calls for immediate attention. In making the repairs that I speak of, only two rows of blocks were removed. The new blocks that were put in were of pine which had been dipped in a creosote preservative, which material, by the way, is nothing more or less than a crude form of carbolic acid. However, it is well to say that in making this repair only the inside row of blocks was renewed. There were enough old blocks of good quality for the outside row. There was a space of two inches between the inside row of blocks and the stone curbing. This was filled with Portland cement concrete. The space between the other blocks was about half an inch, and this joint was filled in the same way. The blocks in the street were not surrounded with cement, tar or other composition; they were laid dry. In noticing this repair work I observed a new trick in mixing cement—that is, it was new to me. The cement and sand were mixed dry, in the usual way, then the water added and mixed, and rubbed in the joints of the gutter with a steel wire brush. The wires were about four inches long and the brush was attached to a stick about the length of a broom handle. It had the effect of most thoroughly incorporating the water very quickly with the sand and cement, at the same time that it forced every particle of slush into the joints between the blocks and the stone. These joints were filled nearly full of sand before the cement slush was rubbed into it. I was able to examine the concrete under the blocks and found it in good condition. In one place where they had cut it out to repair a sewer connection, I saw that it was about seven inches deep, though the lower part did not form a very rich concrete. The bed below it was natural sand. The concrete under the sidewalk was four inches thick over a sand bed, with a five-eighths inch coating of asphalt.

The asphalt sidewalks which they are now putting down are different from those laid a few years ago, and I should say different from anything with which Americans are generally familiar. The asphalt is almost pure; no sand or cement is used with it. A little fine gravel or coarse sand is sprinkled over the top of it while it is hot, but only a very little. There will frequently be places as large as one's hand where there is nothing but pure asphalt. I am told that the omission of sand in this composition renders it possible to melt over the asphalt and use it again in case of the failure of any part of the walk. It also permits it to be made much thinner than when it partakes of the character of a composition.

The granite walks in Paris are not as well made as those in Glasgow, nor are they in any way as satisfactory. In truth, granite walks are not well received here. In Glasgow it is used in preference to any other, and the block pavement and asphalt, so common here, is not received with much favor there. There is a good reason for this. There is every reason why the people of Paris should not like the granite pavement, while there are abundant reasons why the people of Glasgow should be pleased with it. Paris does not know how to lay a granite pavement as well as do the people of Glasgow. That is all there is to it. The readers of PAVING know that Glasgow lays the blocks on a concrete foundation, a foundation made either of cement, sand and broken stone, or broken stone and bitumen, which makes a solid bed, the cem-

ent concrete being regarded as the best. Paris lays her granite pavements on sand, and they are not relatively satisfactory.

This illustrates as clearly as possible, how it is that one section of the country may say that one pavement or another is a dead failure, and all on account of the way in which it is put down. In listening to general statements that one pavement or another is a failure, I think we should pay very little attention to them unless we are acquainted with all details of their construction. I can conceive that a brick pavement, wood pavement, asphalt or any other, might be regarded as altogether unworthy through mistakes in their foundation, a foundation specified, possibly, by some misguided engineer, or board of public works. If the evidence which has come to me on this side is worth anything, I feel confident that no pavement will prove satisfactory which does not rest on a solid foundation. If the pavement is of brick, wood or stone, the



foundation should be of concrete made of gravel and sand, or broken stone and tar, pitch or asphalt. I know that there are advocates of sand foundations, for brick and wood pavements, but I am thoroughly convinced that this is a mistake. Sand may be used as a thin covering over the concrete as a cushion for any of these, but I believe it is a mistake to use it as the only foundation. I wish it understood that I am not advancing this as a theory of my own, but rather as the result of what I have seen. I have not seen a satisfactory pavement on a sand bed, nor have I seen one that is unsatisfactory on a heavy concrete bed. I believe the reputation of any surface material will suffer if it is resting on a sand foundation.

Cheap foundations are often advised by those who have a surface covering to introduce. They advise it, not because they want to, but because they fear that the expense of a good foundation will make it impossible to introduce their surface covering. A worse mistake than this can hardly be made. A pavement may have every merit, and yet its successful introduction be delayed for years on account of mistakes made in the experimental foundation. People see the surface; they do not see below the surface. They see that Mr. Brown's pavement is uneven; that it is going to pieces. "Mr. Brown's pavement is not good; we will have no more of it."

The prices which people have paid for pavement in America indicate that they will pay almost anything for a good one. The writer has had some little to do with the letting of contracts for many years. His position has been that of a middle man. It is his experience that people will pay what they have to for any good thing. They will squirm a good deal and try to get it cheaper. The man who knows how to sell can hold out and get his price if he has the superior article. In pavements it is strictly a question of quality. Any one who puts in a cheap foundation for the sake of undercutting his competitor will get the worst of it.

The care of pavements by the city bears a definite relation to the success of any material used for paving. In a city where a pavement is put down and left to itself, where it is not clean or in any way looked after, the pavement, rather than the city officials, suffer. People say, look at the condition of our new, high-priced pavement. It is as bad as a dirt road. They exaggerate imperfections. The next time that city has a pavement to put down it takes another kind. When the officials from another city come to visit, those who are really responsible for the condition of things do not recommend the pavement, which has been ruined through their own carelessness. Any one who visits Liverpool would not be very highly impressed with wooden pavements. Coming to Paris where they are clean, carefully looked after, they will receive a high estimate. I say this in the interest of business men who are putting their money into street paving business. This matter of guaranteeing pavements by the contractor is an absurd, wrong thing brought about by competition. The company which guarantees a pavement at the same time guarantees the care which it will receive from the city. They guarantee its cleanliness; they guarantee against many things which may injure it, and which are difficult to prove or set forth.

A good water supply to a city is a pre-requisite for good paving and in order that the water may do its work properly, rather than injuriously, the grade of the gutter and the general surface of the street should be uniform and smooth. The streets should be kept constantly in such a condition that the water will run off; that it will clean it rather than saturate it. It is in this that Paris and Glasgow are so very particular. In either city a piece of burlap thrown next to a hydrant will turn a current of water one way or another. The grade is so nicely adjusted that this is possible. In Paris the gutters for the stone block pavements are made from the blocks themselves with cement between joints, while in Glasgow the gutters are formed with flat channel stones.

GOOD ROADS.

AT a recent meeting of the Engineer's Club of Philadelphia, Thomas G. Janvier read a paper on "The Engineering Features of the Road Question."

This branch of the road question should be divided into three parts: 1st, location; 2d, preparing the road-bed; 3d, laying the pavement.

Location.—The item of expense should be well considered. In this connection grading, land damages, etc., should not be overlooked. The line should be direct as possible, remembering that a slight deflection to the right or left, or any easy curve, might save considerable expense in the matter of excavation, embankment or bridging. The grades should be made as easy as possible, not exceeding seven feet per hundred, or less than eight inches per hundred feet. Excessive excavations and embankments should be avoided.

The full width should not be less than forty nor more than sixty feet, but the paved portion need only be from eighteen to twenty-four feet.

The road-bed, or sub-grade, should have the same shape as finished grade.

Pavement.—If intended for very heavy travel, the Telford pavement should be put down, but if for ordinary travel, macadam will answer. The difference in cost of these two pavements is but slight, and the Telford being much superior, should be given the preference.

A Telford or macadam road thoroughly constructed and properly maintained will never need reconstruction. The best system of maintenance is that of constant daily attention and repairs. All dirt roads intersecting a paved road should be paved several hundred feet from the intersection, in order that as little mud and dirt as possible shall be carried on to the paved road.

Important points to be observed for keeping a road in good condition:

1. All dirt and mud removed as frequently as possible.
2. The entire drainage system carefully maintained.

3. Constant daily repairs and patches wherever and whenever ruts or depressions begin to show.

4. Careful sprinkling three or four times a day in dry weather.

5. The frequent use of a two and-a-half-ton roller.

PAVING BRICK AND BRICK PAVEMENTS.

By C. P. Chase.

Having now treated of the composition and value of the different clays and modes of burning, it may be well to enumerate here the machines and number of men necessary to operate a thoroughly equipped brick plant. The complete plant, as used by the Purington-Kimball Brick Co., two years ago, is taken as an example.

One steam shovel for getting out clay, with the capacity of enough clay for 225,000 brick in ten hours.
Four machine men.
Four machine boys on platform.
Eight men at the pulverizer (Cockerell).
Two men at hoisting machine.
One engine man on steam shovel.
One fireman; one crane man.
Six men in the clay bank.
Twelve boys loading cars and handling green brick.
Four men to put cars in the dryer.
Four fire dryers, and take cars out.
Four fire dryers, and take cars out at night.
Twenty-four men setting and wheeling.
One engineer, one fireman, one carpenter.
One blacksmith, three laborers.
Eighty-three, total.

Before burning, the brick are put in drying tunnels and all moisture driven off. These tunnels are 36 inches wide, 48 inches high, and are heated by coke. It takes one ton of coke to dry 150,000 brick. Crude oil is used as fuel.

Paving brick proper have had their reputation greatly injured by the use, for paving, of soft, inferior brick, sometimes tarred or creosoted. A good example of this is the brick paving of Nashville, Tenn. Quite a large amount of pavement was laid with creosoted brick; in a little while they began to fail, and soon the whole country knew it. It was not until lately that the writer understood the real cause of the failure. In looking over one of last year's numbers of the *Engineering News*, an article on the failure of this pavement was found, which, after noticing the failure, ended by saying, "The brick were the common red brick creosoted." No wonder the pavement failed. Common red brick were never intended to resist the shock of heavy carts or blows from steel shod horses, and a brick that will take up tar or creosote will soon be taking up moisture.

Unjust comparisons are made between granite or sandstone pavements of some of our large cities and brick pavements of the west, the persons making the comparisons forgetting that the first is usually on a hydraulic concrete foundation, and the brick invariably on broken stone or gravel.

Again as to the economic question. It would not be economical or just to ask a person owning a $1,000 lot in a town of say 12,000 population to spend $1,000 or more for a granite or asphalt pavement in front of it, whereas in New York or Chicago the pavements at the same price would be a small item in comparison with the value of the same size of lot.

It is probably owing to this last cause that a foundation peculiarly its own has been adopted for brick pavements, being generally six to nine inches of broken stone or gravel well rolled, and a cushion of sand on this. This foundation will answer all purposes in the average city of less than 30,000 inhabitants. For larger cities or for an exceptionally heavy traffic the brick should be set on concrete foundation. Of course side streets in even our largest cities could use the lighter and cheaper foundation. The broken stone can not be too well rolled, and work must be well looked after to see that this is done and that the requisite amount of sand is put on and *washed in* before a brick is laid. The roller used on the stone or gravel should always be heavier than any load that will come on the pavement in the future. The results obtained have been generally satisfactory.

At Des Moines, Iowa, they have about ten miles of brick paving. The author went over and examined nearly all of it last winter, and it seemed to be in fair condition, although the brick are not hard as some in use in other places. The streets at that time were in good condition, and as far as slipperiness on grades is concerned, seemed to give as good a foothold as any of the other pavements in use there. In laying this pavement the street was brought to the required grade by putting in nine-inch layers of filling and rolling with a roller weighing 1,800 pounds to the foot, then three inches of sand, on this a course of brick laid flatwise with their longest axis parallel to the street, then a layer of sand sufficient to even up and fill spaces between the bricks, and on this a layer of brick on edge at right angles to the street.

At Bloomington, Illinois, the people are unanimous in favor of brick. City Engineer Bell says, "We have tried stone blocks, Nicholson and Macadam pavements, and still have samples from which to draw our own conclusions, but the citizens of Bloomington are a unit in favor of brick for future street pavements. The reasons for this are cost, durability, lack of noise and general satisfaction." Now probably the first thing the reader will say is that Bloomington is a small town and can have no heavy traffic; here you would be entirely wrong. A line of paving running to the depot has been down seven years, and all freight to the depot and all coal from the coal shafts, a very heavy traffic, passes over it, still it shows no appreciable sign of wear.

Some of their pavements are fifteen years old, and are but little worn and in good shape, except where they have been disturbed and were not properly relaid. The manner of laying is as follows: Foundation brought to proper shape and well rolled, then a course of cinders is spread on and compacted by rolling, on this is placed two inches of sand, then the first course of brick on their flat sides with their long axis parallel with the street. Next comes an inch of screened sand, and then a layer of brick edgewise on their two-inch surface, and long axis at right angles to the street. The brick are then covered with sand, which is swept into the cracks, and the whole pavement rolled with a heavy roller.

There is no necessity of the sub-course of brick being as hard as the upper course, but care must be taken to break joints in both courses. The entire pavement, including all materials, grading and stone curbs, cost $2.00 per square yard.

Decatur, Ill., lays pavement in much the same way

The specifications in abstract are:

First.—Foundation brought to desired crown twelve inches below grade and rolled with a heavy roller.

Second.—A course of clean gravel, none larger than a robin's egg.

Third.—One course of brick flatwise, then one and one-half inches sand and a course edgewise, and brick brought to a surface by striking with a maul on a plank.

Fourth—Sweep in dry sand.

Fifth.—Brick are extra hard and vitrified; cost $1.50 per yard.

The oldest brick paving at this place has been down six years, and shows but little wear.

At Steubenville, Ohio, hard burned brick are used, chiefly obtained from New Cumberland, West Virginia, and have given satisfactory results. The brick are laid on foundations of gravel similar to the preceding.

The wear is estimated at one-fourth to one-half of an inch in five years. Cost, $1.00 per square yard.

The city of Burlington, Iowa, has put down 50,000 square yards of brick paving in the last two years, and will lay the same amount this season. The citizens are decidedly in favor of brick.

Their specifications are:

First.—Earth road bed excavated to required depth, made of the desired shape and rolled, all depressions being filled with sand or gravel.

Second.—A layer of gravel or macadam, which is wetted and rolled.

Third.—A layer of clean river sand is put on the gravel, and this well rolled and settled by watering.

Fourth.—On the foundation thus formed a course of hard brick

is laid on the flat side, lengthwise to the street. On this a course of clean sand to the depth of one inch.

Fifth.—A top course of the very best and hardest brick set on edge, their longest axis at right angles to the street, and this course covered with sand enough to fill all cracks, and the whole rolled until it conforms to the required grades.

At Cedar Rapids the brick pavements seemed to be in fair condition, although the quality of brick could be improved.

Peoria, Illinois, has obtained satisfactory results from its brick paving. Franklin street, which has been paved three and one-half years, is one of the principal streets and has a very heavy traffic. As yet it shows little or no signs of wear, and is as pleasant to ride on as asphalt. The brick used are larger than ordinary, being four inches thick, twelve inches long, and five inches deep, laid on five inches of rolled gravel, and the joints filled with sand. Contract price, $1.70 per yard.

Davenport, Iowa, has some excellent brick paving; it has not been down long, but up to the present time it has been very satisfactory. Bardolph brick were used.

At Clinton, Iowa, a considerable amount of brick paving was laid last year, but here there were slightly differing conditions, which led to another manner of laying the brick. It had been decided to lay two courses of brick, but on cleaning off the dirt on the streets it was found that a hard, firm layer of the old macadam paving remained which could be used for a foundation. On this enough rubble was placed to bring the street to within six inches of the grade of the top of the paving, and this was rolled with a heavy roller; on this a two-inch layer of sand, and then one layer of brick laid on edge, the long axis at right angles to the street. Where there was no macadam to build on, a foundation of stone and sand was prepared, and allowed several weeks to settle and be bedded down by passing teams.

This pavement is but a year old (October, 1890), so nothing can be said of its wear; but one thing was learned which was of great importance. The last winter being so broken, continually thawing and freezing would of course be a hard test for any brick that would absorb much moisture. The brick were carefully examined, and all the brick that had failed were found to be those that had not been vitrified or had been badly cracked in burning. There were not a large number, but sufficient to show that brick, no matter how hard or compact they are, will not do for paving unless evenly burned and vitrified.

The brick used were principally London Mills and Le Clair.

What is known as the Hale System of paving has been quite extensively used in the East, and has given quite satisfactory results. The main feature is a layer of tarred boards for a foundation.

The whole system is:

First—A layer of sand.

Second—Tarred boards.

Third—Another layer of sand.

Fourth—One layer of brick laid "herring bone" style.

The simplest method of tarring the boards is to have a board box, say 20 feet long, 20 inches wide and a foot deep; along the bottom of this a steam pipe about 1½ inches in diameter is run and returned, a little steam sufficing to keep it hot. A man stands at each end of a board with a pair of tongs and lifts the boards in and out and piles them up ready for use.

The boards used should be clear and free from sap.

Where used, this has been pronounced a good foundation.

The oldest piece of pavement on this plan was laid in 1873, now seventeen years old; the boards and brick are still in good condition, and have been all the time in constant use.

The cost is about $1.25 per square yard, and the royalty for using the patent is 10 cents per square yard. A large amount of this has been used in the East and Southeast.

At the convention of clay-workers held recently at Indianapolis, Indiana (1889), a brick taken from an exposed part of one of Burlington's principal streets was presented for examination. It was estimated that three thousand vehicles passed over the spot in one day. As to the result: the expert brick men found it difficult to tell with a certainty which side of the brick had been exposed to the wear and tear of street travel, and which had been protected by resting on the sand. There were no marks, no chipping and no stain to guide a person in telling which side had been uppermost. The brick was thoroughly vitrified, very compact, and would not practically absorb or retain on its surface any ordinary liquid.

In Mr. Love's work on pavements, just published, a number of flattering testimonials are given in regard to brick pavements. But I have found no account of a brick pavement, first class in all particulars, failing. In Mr. A. H. Perkins' "Information on Pavements" quite a number of failures of brick are noted, but the kind of brick, composition, manner of burning, strength, or absorptive tests are not given, so that the statements are valueless and unjust for comparisons. The reader is led to believe that the brick of ten years ago are the same as those of to-day, as a review of these statements will prove.

General Gilmore is quoted as saying, in 1885, that "it is claimed that bricks saturated with liquid hydro-carbons will sustain great weight without crushing, and will resist abrasion and wear, when subjected to ordinary street traffic, but no satisfactory evidence on these points, based upon their practical use, has been obtained."

The statement is all right, but in the five years since 1885 it has been proved that a brick which will absorb any liquid is not fit for a pavement.

The report of Captain Eugene Griffen, United States Engineer, on brick in 1887, says: "The record of brick is an irregular one," etc. This is too true, but how could it be otherwise when brick are burned in *up-draft kilns* with the irregular heat of wood as a fuel, and in another place a fire brick with enough lime in it to disintegrate it; or one company making a brick from half ground coarse clay, another from fine. Again, he says: "Brick may be burned in the same kiln and by the same workmen," but as before said, wood fires or other than oven kilns can not be depended on for fine work.

Mr. H. M. Claflin says: "The Topeka people have tested all kinds, and have declared against fire-brick." Turning back a few pages we find this statement: "A committee of five eminent citizens report that the difficulty of uniformity of material, uniformity of burning, the uncertainty as to special kinds of clay required, and the absence of any clay in this vicinity known to be adapted to this purpose, make a brick pavement at this time (1886) in Topeka a very doubtful experiment." I have already answered the questions as to non-uniformity in material and burning. Uncertainty as to kind of clay is also a thing of the past.

On page 16 of the same pamphlet this statement is found: "If one brick in each square yard of pavement be bad, it will make the whole pavement bad." Now in the first place, with our ordinary western paving brick one bad brick for a square yard is a very excessive statement, and what is more to the point, it does not make the whole pavement bad, where the streets are kept in any sort of decent shape. A soft or an over-burnt brick does not lose its shape entirely, and under any ordinary inspection such a brick would be discovered, and in a few minutes could be replaced by a better one, without disturbing the rest of the pavement.

In an article recently published in *Paving and Municipal Engineering* of Indianapolis, Ind., and written by the city engineer of Columbus, Ohio, the life of paving brick is put at ten years, and other pavements are given with a life as high as forty years. The statements and table are misleading. The statement is either made from willful negligence or lack of knowledge, as there are many pavements that have lasted fifteen years and are in splendid condition; several are over eighteen years old and are giving satisfaction with no signs of failure, and the list of ten-year olds in good condition is large and satisfactory.

The cut showing the different manner of laying brick is for the purpose of illustration only, the crowning of the street and size of brick being exaggerated, although the relative proportions of the materials are true. Fig. 1 shows the Hale pavement in section, and the plan of the same; as is seen in the cut, a few triangular bricks are used next to the curbs, as the brick are laid herring-bone style.

Fig. 2 shows the pavement laid at Clinton, Iowa. The large stone on the bottom are the remains of an old macadam pavement. On this come the rubble, sand, and then brick.

Fig. 3 is the general form of brick pavement laid in the west, being first soil, then sand, gravel, broken stone, or cinders, first course brick, one inch of sand, and then the top course of brick.

[Cut referred to will appear in next number.]

The under course of brick is calculated to take the place of concrete or other solid foundation. It is very good considering the item of cost.

Where brick pavements are laid on concrete, the author does not think the brick should be bedded in the concrete, but that there should be three-fourths to one inch of sand between. This would be sufficiently firm and yet would give great elasticity.

In all pavements, no matter what the foundation is, the curbing should be cemented together with Portland cement as soon as it is set in place. This is to prevent the water from running through the cracks and washing out the backing. The specifications should also provide for a substantial backing to the curbing, as failures often occur next to the curb, owing to its dropping back out of line. In sand-filled pavements the author thinks the cracks between bricks for five feet out from the curb should be filled with either cement or an asphalt composition. As for the rest of the street the water runs off of it so quickly that the sand between the brick, with the fine particles of dirt that sift in, forms a sufficient filling to keep out water.

In Prof. I. O. Baker's pamphlet on brick pavements, just published by T. A. Randall & Co., of Indianapolis, Ind., a number of tables are given showing the remarkable durability of paving brick. His tests show an average crushing strength of 7,500 pounds to the square inch, and transverse strength of 1,360 pounds per square inch. The tests for absorption and abrasion are equally high. All his experiments show that brick are more durable than anything except granite. The authority is unquestionable and the experiments reliable to the extent that he claims for them.

In the Warren-Scharf Asphalt Paving Company's pamphlet of arguments against brick and in favor of their sheet asphalt, the cost of brick pavement is put altogether too high ($2.60 per yard), as will be seen by referring to the actual cost of brick in cities referred to in this paper. They also claim that sheet asphalt, under ordinary circumstances, affords as good a foothold as brick. But we can not see how that is possible, as the spaces between the brick act on the same principle as cleats on the floor of a treadmill.

As to whether paving brick should be vitrified is a question which has been much discussed, but on the whole we believe this should be answered in the affirmative, because any brick that will vitrify can be annealed. The annealing is the process of toughening by slowly reducing the heat, and a brick that is properly annealed will, as a general rule, be tough and elastic. In all that has appeared against vitrified brick, nothing has been said about annealing. The fault of brittleness lies mostly with the brick-maker. Overcrowded with orders, in his hurry to cool off his kiln and get the brick out, annealing is entirely neglected. The brick are brought to a white heat and then the fires are allowed to die out too rapidly and the brick become brittle. We have known this to be done by several companies during the last season, and the injurious effect was plain to be seen by comparing the brick with those formerly burned by the same companies.

Of course there are some hard burned brick that it would not be practicable to vitrify, owing to the character of the clay, that make reasonably good pavers. In accepting such brick the engineer should use his best judgment.

In conclusion, it will be well to sum up the comparative merits of brick as shown by the latest experiments and facts taken from actual service.

RELATIVE RANK OF MERIT.

Durability under traffic.	Cost.	Action of Elements.	Noise and Dust.	Repairs.	Service on Grades.
1. Granite.	Brick.	Brick.	Asphaltum.	Brick.	Granite.
2. Brick.	Wood.	Granite.	Brick.	Granite.	Brick.
3. Asphaltum.	Sandstones.	Sandstones.	Wood.	Sandstones.	Sandstones.
4. Sandstones.	Asphaltum.	Asphaltum.	Granite.	Asphaltum.	Wood.
5. Wood.	Granite.	Wood.	Sandstones.	Wood.	Asphaltum.

Further than this we have for health: 1, asphaltum; 2, granite; 3, brick; 4, sandstone; 5, wood. Granite and brick, in fact, standing about equal.

As to the qualities of clay, we may conclude that a clay that will make a first-class fire brick makes a poor paving brick, and *vice versa*.

The clay from which our best paving brick are made is more properly a potter's clay.

The material should be finely ground and thoroughly mixed. The burning should be in the form of kiln where all parts can be burned alike.

The brick must be properly annealed and the kiln cooled gradually.

The brick for paving should be carefully selected and subjected at least to the ordinary tests, to-wit: absorption, abrasion, and transverse strength.

The amount of material necessary for one mile of pavement in the Hale system, and in the one-course system used at Clinton, Iowa, is seen in the following tables.

For two courses, add fifty per cent. to the number of brick.

The size of brick used in the tables is 8 inches long, 4 inches deep, and 1½ inches wide.

The standard size for paving now is 8½x4½x2½ inches.

ONE MILE PAVING IN CLINTON.

Width of Street.	Surface in square yards.	Number of bricks.	Cubic yds. sand.	Cubic yds. rubble.	One course.
20	11734	950535	2933	5867	First rubble, then sand, and then one course of brick.
30	17600	1425600	4400	8800	
40	23467	1900327	5866	11733	
50	29778	2411018	7444	14889	
60	35200	2851200	8800	17600	
70	41067	3326427	10266	20533	
80	46978	3805218	11744	23489	
100	58667	4752027	14666	29333	

ONE MILE HALE PAVING.

Width of Street.	Surface in square yards.	Number of bricks.	Cubic yds. sand.	Feet lumber.	Barrels tar.
20	11734	821380	1956	105600	176
30	17600	1232000	2800	158400	264
40	23467	1642690	3911	211200	353
50	29778	2084460	4963	264000	447
60	35200	2464000	5867	316800	528
70	41067	2874690	6845	369600	615
80	46978	3288460	7829	422400	575
100	58667	4106690	9778	528000	880

[TO BE CONTINUED.]

MUNICIPAL ENGINEERING; WHAT IT IS, AND WHEN NEEDED.

By Robert E. McMath, Mem. Am. Soc. C. E., and Consulting Engineer.

THE young and smaller, but ambitious, towns, villages and cities often suffer great disadvantage and ultimate loss, because they do not know when and for what they want an engineer. Nor do they always apprehend that when an engineer is needed, it is always good economy to employ a capable one, and to call him in promptly.

For the sake of clearness, let us distinguish between surveying and engineering.

Surveying, in connection with engineering, is the location of existing things with a view to their being represented in their relative position by maps and profiles, for the use of the engineer. The surveyor's function includes also the location of plans on the ground.

Engineering design is the taking of existing or anticipated facts and relations, and fitting to them plans which will accomplish desired results with the least expenditure of material and force, (usually measured by money). Engineering construction is the carrying out of the plans by the use of appropriate means.

The two functions of surveyor and engineer may be united in the same person, but usually expert engineers do not themselves make surveys. A third function is required in the supervision or inspection of work; it calls for another order of ability, largely made up of good sense in combination with experience.

It is thus made apparent that surveying and inspection of work are of the character of skilled labor; and that engineering is professional service. Also that the ordinary need of a moderate sized town is met by the surveyor and superintendent. The higher priced professional man is needed only occasionally. What he is needed for, it is the purpose of this paper to set forth.

Street Grades and Plans.—Every town that expects to live should, at a very early stage in its history, establish the grades of streets and avenues to the full extent of the town plat, and, in doing so, keep in view the probability of their further extension. In new towns this ought to be done when the town is laid out, and the grades might be made part of the original record.

A very few days' work by surveyor in field, and by engineer in office, will suffice for making a complete set of profiles, and to fix a system of street grades, harmonious, convenient and economical. The street-making material available for the locality should be studied, general plans of street improvements made, and specifications drawn to govern the construction.

Culverts and Bridges.—Culverts and bridges will naturally receive attention in connection with street grades and plans. To determine the size, and, consequently, the cost of these requires the exercise of trained judgment, that they be sufficient and not excessive. Foundations must be properly secured, and material and workmanship clearly described in specifications. Quite often a stream is not only to be bridged, but its course controlled, its floods guarded against, and pollution and misuse prevented. Prevention is easier than cure, and cheaper. Competence to handle these matters does not come by inspiration, it is gained by experience, not in the schools.

Water-Supply.—It is a mooted question whether provision for a public water-supply or sewerage should come first. That there are good reasons for the precedence of either, proves that they are not safely separable. In point of fact water-supply will be first agitated, frequently at the instigation of the commercial agent, who has materials to sell, or by the franchise seeker. These have a legitimate field for their enterprise, but as a rule they do not keep within its limits.

As to a water-supply, there are preliminary questions that are of prime importance to the customer, concerning which the material man and franchise monger care but little, such as: What sources of supply are within reach? Is the water fit and safe for domestic use? Can its character be preserved? Is it sufficient in quantity for present need? Can the quantity be increased? After these questions are answered, and the answer must be sought disinterestedly, a competition between parties furnishing outfits, or seeking contracts, will be to the advantage of the customer. The interests of the town are only safe in the hands of the professional man who has high regard for his own reputation; no interests separate from that of those who seek his counsel; nothing to sell but his services; no preference for this firm's pump, or that one's boiler, valve or other fixture.

Sewering.—Water brought to the premises and fouled by use, must be gotten rid of. Even if the house be isolated, and the occupants few, the freer use of water when in constant supply makes the disposal of wastes difficult. The importance of a safe disposal of such wastes increases in geometrical ratio, as the number of persons living close together increases. The difficulty usually diminishes in like but smaller ratio.

The community acts wisely which gives early attention to drainage. The alternative is, many an empty chair at the fireside; many a grave in the cemetery occupied; many an invalid laid aside from usefulness to suffer; many a case of sickness, wholly or in part recovered from, which need not have been.

When the need is felt, the tendency is to resort to temporary measures. Commonly the first who realize the necessity are forced to help themselves the best they can. Thus drains are run to water-courses; the material used may be of the cheapest grade, the work done carelessly, and all excused on the plea that it is temporary, and will answer until we can do better. A long experience in the administration of sewers in a great city convinces the writer that nothing short of autocratic power can rid a community of the evils arising from temporary drains if once allowed to exist. The tenacity with which the average citizen clings to what he esteems his rights; the complacency with which he shows his immediate premises, and claims that his drain is all right; the impossibility of legal proof that a nuisance, not on his immediate premises, is caused by him, all enforce the proposition that temporary work should be avoided if possible.

The way to avoid this and other evils is to have a sewer system for the town designed and established, independent of the prospect of its immediate construction. Then all drains laid may properly be required to conform to the system. The cost of procuring the plans for a system is not great, and will be repaid over and over by the saving to owners which will result from their being able to put in their drains so that they need not be reconstructed or abandoned. For let it be understood that the design and adoption of a sewer system does not imply the immediate construction of any part of it. Nor, when construction is begun, is it necessary to sewer the whole town. The issue of bonds and letting the work as a single contract is often very poor policy. A cheaper and better way is to let the sewers grow according to plans, as the need for them extends. If the town is so situated that the sewage must eventually be purified, and most of them are so situated, then storm water from yards and roofs must be rigidly excluded from the sewers; if there be much ground water it, too, must be excluded. If these absolute demands are foreseen, the house owner can conform to them in anticipation and thereby save money and annoyance. Again, the having a definite plan greatly expedites the construction of the more important parts of a system.

It is of the utmost importance that the question of ultimate sewage disposal be considered and kept in view from the outset. A very few cities are so situated that their crude sewage can be discharged into rivers so large that no further consideration need be given it, until the country shall have a population density manifold greater than now. Many can for the present discharge their sewage into water-courses, but must look forward to the not distant time when the pollution must cease. The choice will lie between chemical and land purification, or a combination of the two.

If an irrigation or filtering field is within reach of a town it should be located and surveyed in connection with the sewer plans, so that the main sewers in direction and elevation may go towards that field. If chemical processes are to be used, by themselves or in combination with filters, the best site for the works should be located and the sewers designed with reference thereto. If these future necessities are disregarded, it will seem so convenient to let the outlet sewers drop to the bottom of water-courses, that the mistakes of many older cities will be repeated at the cost abandonment and relocation of mains, which might as well have been built right at first, or, as an alternative, to pump sewage that might have been delivered at the purification works by gravity.

The time was when the purification of sewage was supposed to be capable of accomplishment in many ways. It took many and costly experiments to prove that the practical methods are few. Processes are not perfected, but their general nature and limitations are so well established now, that the sewer engineer can readily determine which method is best in any case. If the sewer system is designed with reference to the method of disposal, the details of that method may be left open to improvement.

House Drains.—Closely related to the sewering of a town is the regulation of house draining and plumbing. It is essential that the regulations be in harmony with the sewerage plans, and that they be enforced. The smaller cities can have as good and practical a code of regulations as can the large, and with the co operation of owners can enforce them as well. With competent advice such a code can be framed to suit the local needs. It will not do to copy —nor to follow volunteer advice. Amateurs overload, and tradesmen can not forget their own interests.

Lighting.—The lighting of cities is so universally in the hands of contracting gas and electric light companies, that the services of the municipal engineer are needed only in the making of contracts and drawing up of specifications. It may be well to emphasize *needed*, for they are seldom called for. Too commonly the preparation of these is left to the experts and attorneys of the contracting party.

Franchises.—Municipal engineering may properly include advice concerning franchises to use the streets, overhead, surface and underground. The importance and value of these privileges are just beginning to be appreciated.

Having in the preceding paragraphs glanced at the several more important branches of municipal engineering, it will have been seen that towns need to consult with an engineer before the difficulty arises rather than afterwards; just as the prudent man does with his attorney.

Municipal engineering does not often call for high scientific attainment or mathematical ability; it always requires a trained and impartial judgment in addition to intelligent familiarity with what has been and is being done in cities the world over.

PORTLAND CEMENT.

By United States Consul-General New, of London.

THE manufacture on an extensive scale of Portland cement, which is the trade name given to nearly, if not quite, all the cement made in England, is a comparatively new industry, having been developed almost entirely within the last twenty-five years.

It is made cheaper and of a superior quality in England for the reason that its constituent elements, *i. e.*, chalk and clay, both of a peculiar chemical formation, are found here in great abundance in the same localities and easy of access. The manufactories are principally located in the counties of Essex, Surrey, and Kent, on the Thames, Medway, and tributary rivers, which afford cheap transportation for the raw and manufactured product.

These manufactories, about forty in number, represent a very large outlay of money and labor and employ thousands of men all the year. In addition to these, there are a few smaller cement manufactories in northern England, which do not enter seriously into competition, however.

The process of manufacturing is not complicated and requires no great amount of machinery aside from the mills used in crushing. Both the clay and chalk, which are found in the so-called cement district, are very plentiful, close to the surface, and easily quarried. Their mixture in the proper proportions is made by experts very carefully, and, after the amalgamated product is properly calcined, it is crushed, tested, and packed ready for shipment. The chief difficulty in the manufacture is found in unexpected chemical combinations, which frequently occur, and which so alter the character of the product as to make it unproductive of the best results.

For this reason each day's product is very carefully tested, as it comes from the mill, and if it falls below the standard is rejected.

A cement that answers all the requirements possesses the following qualifications:

(1) Fineness to be such that the cement will all pass through a sieve having 625 holes to the square inch, and leave only 15 per cent. of residue when passed through a sieve having 2,500 holes to the square inch.

(2) Weight per struck bushel to be not more than 116 pounds, nor less than 112 pounds.

(3) Specific gravity to be between 3 and 3.05.

(4) A pat made with the minimum quantity of water to be set in not less than 3 hours nor to take more than 6 hours.

(5) Tensile strength. Briquettes which have been placed in water 16 or 17 hours after gauging to carry, at the expiration of 7 days, 400 pounds per square inch without fracture, and at the expiration of 28 days from gauging to have increased in strength at least 25 per cent.

(6) Expansion or contraction. Pats left in air or placed in water to show no cracks or other signs of deviation in form.

(7) Color. The cement to be of a cold gray color, and when gauged to show no change if left in either air or water.

A cement that possesses the foregoing properties may be considered a fair sample of a true Portland cement and would be suited to any work where great ultimate strength is required, and at the same time it is such a specification that no manufacturer would object to work up to.

It is the contention of the manufacturers here that their cement is of a better quality than that made in any other country, for the reason that the materials are better and freer from impurities. Portland cement has for its base before calcination carbonate of lime, which is generally found here naturally combined with silica and alumina, or the mixture is artificially arrived at, and the proportion which these ingredients bear to each other, the intimacy of their mechanical mixture, and the degree of heat to which they are subjected determine the quality and properties of the result, so far as the chemistry of the product is concerned.

The fineness to which the grinding is carried, the warehousing and the care bestowed in the manufacture likewise have a determining result on the product.

The various processes, sparticularly the proportions of the materials used, are generally kept secret, and it is very difficult to ascertain the details. In Germany and Austria and some other countries on the Continent the matter of testing cement and regulating its manufacture are taken in hand by the government.

In England, however, only general vague laws and regulations laid down by practice have been adopted, and, as a consequence, the results obtained by different experimenters are not so uniform as could be desired, each having used the means and adopted the standards of quality which appeared to them to be best.

EXPORTS.

From the official reports on the subject, the exportation of cement from England to foreign countries during the year 1888 was as follows:

To—	Quantity—tons.	Value.
Russia	7,449	$66,200
Sweden and Norway	5,192	47,665
Germany	8,277	72,195
Holland	17,325	173,985
France	132,220	127,960
Portugal	6,250	60,990
Spain	9,576	87,005
Roumania	5,878	52,075
Egypt	10,685	93,260
China	4,220	34,195
Japan	14,826	126,955
United States	187,058	1,790,525
Venezuela	10,686	103,240
Chili	7,025	67,830
Brazil	14,324	149,320
Uruguay	9,947	96,900
Argentine Republic	57,558	552,425
Other foreign countries	15,170	157,980
British colonies	208,128	1,984,295
Total	612,702	$5,825,000

No figures are obtainable as to the sale and consumption of cement in England.

COST OF MANUFACTURE.

In response to inquiries made of various manufacturers as to the first cost of making cement, evasive answers were in every case given, the gentlemen stating that for business purely they must decline to give the information desired. All strenuously insisted, however, that the business, as at present carried on and at the present prices of the product, did not give an adequate return upon the investment made. It was stated that the average profit in the business during the past few years was not in excess of 4 per cent. upon the investment and operating expenses. The present price at which cement is invoiced in this consulate-general is from 24*s.* to 26*s.* per ton, with a discount of 2½ per cent. allowed. The product is shipped in casks which are invoiced at about 2*s.* each, and which hold from 370 to 380 pounds each. Employment in the cement manufactories is generally by "gangs," *i. e.*, the men are paid in accordance with the amount of the product, and not per diem.

The average wages, probably, will not exceed 24s. ($5.82) a week, and in many cases will fall below this.

The cement-workers in the larger concerns are generally men who have been so engaged since they were able to perform any manual labor, following the occupation of their fathers and in time transmitting it to their children. The principal competitors of the English establishments are those of Germany, which have developed rapidly in the last few years.

STREET AND HIGHWAY TRAFFIC.

AT the last meeting of the Engineering Association of the South, a paper on "Street and Highway Traffic" was read by J. M. Heiskell, assistant engineer of the Memphis Bridge, Memphis, Tenn., and a paper on "Tests of the Capacity of Sewer Pipe Line to Withstand Internal Pressure," was read by R. L. Johnson, Graduate Fellow in the Engineering Department Vanderbilt University.

Mr. Heiskell's paper was directed principally to the argument that economy of street and highway traffic could best be improved by paying attention to improving the vehicle rather than the road surface, and to accomplish this, recommended strongly the introduction by proper legislation, the following features in the construction of vehicles: 1st, width of tire to be dependent on weight of load; 2d, length of axle to be dependent on weight of load in order to insure non-tracking of vehicles; 3d, a difference of length between front and rear axle to insure non-tracking between front and rear wheels; 4th, the introduction of springs for heavy draft wagons. The paper presented estimates based on quotations from paving companies giving their prices for guaranteeing the maintenance of their pavements for terms of years under present existing circumstances, and also under conditions to be secured by legislation as to the above improvements in vehicles.

Mr. Johnson's paper presented an account of some experiments conducted at the Engineering Department of Vanderbilt University to determine the bursting strength of different sizes of ordinary glazed sewer pipe, with the view to determine the ability of sewer lines and conduit lines made of this pipe, to sustain internal pressure without bursting or blowing out the joints. The paper gave an account of the character of the pipe and the materials employed, and the manner of conducting the experiment. The experiments were made with three sizes of pipe, viz.: 8, 15 and 22 inch in diameter, and the results showed internal pressures running from ten to eighteen pounds per square inch, the pipe and joints both failing at about equal pressures.

LETTING OF CONTRACTS AND COST OF ENGINEERING WORK.

IN the topical discussions of the Illinois Society of Engineers and Surveyors at their last meeting there were two interesting questions considered, the advisability of letting contracts to the lowest bidder and the ratio of municipal engineering expenses to the cost of the work designed and supervised. The discussion of the former was as follows:

Mr. W. D. Clark.—To the first clause I emphatically answer, no! Tenders are often made by irresponsible parties for a sum much less than the works, of whatever nature, can be executed. In almost all contract work there are contingencies to be taken into account, and the contractor is fortunate if he completes his contract without some unforeseen contingent adding to the cost of execution. To the last clause I answer, that all works, either public or private, should be accurately estimated, adding a fair profit, say twenty per cent. Tenders often take a wide range, sometimes as much as two hundred per cent. between the highest and lowest bid, a result of inability on the part of those making the tender to estimate intelligently. Were I to have absolute control I never would accept a tender for less than what I believe the works could be honestly executed, neither would I award a contract to any one except an honest or responsible bidder. Municipalities as well as corporations can better afford liberal prices and secure good work rather than cheap contracts and poor execution. In my experience I am never successful in securing the best work under cheap contracts, and have always been happy in the good fortune of having honest work when at good prices.

Mr. Burnham.—The question is too broad. It applies to the letting of all contracts, whether paid for entirely by public money and let by public officers, or let and paid for by individuals. If entirely individual, private affairs, the common and common sense method of letting contracts is to take the lowest bid when made by the most competent, most trustworthy and best equipped bidder. The lowest bid when made by an ignorant, incompetent, dilatory, or dishonest bidder, is not considered as being in any sense a bid, and is thrust into the wastebasket But in the letting of public contracts, it seems to me, there should be several methods of letting, each of which should be legal, each adapted to the different classes of public work, when classified in some rational manner. Specifications and plans accurately and properly designed should be prepared by competent talent for certain classes of public work, and the letting should be publicly made to the lowest and best bidder, great care being exercised to confine the bidding to competent and trustworthy contractors, and the lowest bidder should have the contract in all these cases. Other classes of work, particularly in small towns where full plans and specifications can not readily be procured, should be let, as is often the case at present, by considering plans and specifications made by the bidder and filed with his bid, as being entitled to as much or more consideration than the lowest bid, and an award should be made to the lowest and best bidder, taking into account plans, prices, competency, honesty and equipment for doing the work. The whole subject is full of perplexity. Awarding always to the lowest bidder insures that the job will very frequently go to the ignorant low bidder; the bidder on the verge of bankruptcy, anxious to keep up appearances till better times, or to him whose chief end it is to cheat and swindle in carrying out the plans. Honest contractors stand very little chance under this system, and would all be driven out of business if all of their work were secured in such public competition. If, on the other hand, full discretion were given to officials to favor such bidders as their judgment approves, the way could at once be open for filling public offices with men who would never award a contract until their own percentage had been arranged for by rules of "addition, division and silence," and our last state would be worse than the first. I see no present prospect of any improvement in methods, can give no light, assistance, aid or encouragement to reformers, if there be any, in this movement, but submit that I believe the subject worthy of our most careful consideration.

Mr. Baker.—It is certainly not best to award contracts always to the lowest bidder. There can be some rules applied to letting of contracts which if properly applied would not leave us in the helpless condition which Mr. Burnham pictures out to us. As applying to the last clause the character of the bidder should be taken into consideration. If his character will not pass for general honesty, uprightness and fairness in his business his bid should be thrown out. Again, the experience of bidders must influence largely the letting of contracts. Every man awarded a contract should have an intelligent understanding of what his contract involves, and if he does not his bid should be laid aside at once. The quality of bidders may be next made a test. I mean their financial ability to conduct the work to completion in the allotted time. If one has not the means or can not get the necessary financial backing, his proposal should not be considered. I think by applying the foregoing rules to all cases of letting contracts, very little trouble would be occasioned in getting the work well done for a reasonable amount.

Mr. Bullard.—My experience has been to always take the ability and character of the bidders into consideration when letting contracts, and have in the last few years let quite a number of contracts to other bidders than the lowest one. This is sometimes a delicate matter, but I usually announce before hand to the bidders that preference will be given to some men over others, and no bitterness or ill feeling is expressed generally.

The discussion of the second question "The ratio of municipal engineering expenses to the cost of work designed and supervised," was as follows:

Mr. W. D. Clark.—In Springfield the engineering is paid from the engineer's fund, and is not charged to public improvement, and unless the engineer keeps a special account of the time devoted to each branch of his work it would be impossible to make accurate estimates of the rate of cost. In sewer construction a superintendent is employed at a stipend of four dollars per day which is charged in the assessment roll, and usually amounts to about four cents per lineal foot. For block pavements three superintendents were employed, their salary being added to the assessment; one for the curbing, one for the grading and one for inspector of blocks.

Mr. Croswell.—In Kankakee it has varied from four to twelve per cent. The difference is due to several causes. The percentage

I find larger on small contracts than on large ones. A smaller force is likely to be employed and requires nearly as much supervision as when a large force is employed. In sewers in wet trenches liable to cave, the visits of the engineer will be more frequent. Some contractors require much more attention than others, at times from inexperience and again from other reasons. I find that most contractors, if their price is too low, require a closer supervision than when the price is fair. When price is too low, it is natural that the contractor should try and save himself, and involves an increased watchfulness, consequently increased cost for engineering. I do not believe in letting work for less than a fair price, but when a contractor is financially good, and bonds good, in small cities it is difficult at times to avoid it.

DISCOVERY OF AN ANCIENT ROMAN PAVEMENT.

HENRY GILLMAN, United States consul at Jerusalem, in a recent report to the Secretary of State, says:

"Some important discoveries have been made during the year in the archæological field. In the months of June and July, when excavating for the sewer and paving of the street running south of the Austrian Hospice and past the Ecce Homo Church and Convent, an ancient Roman pavement several feet below the surface was brought to view. It was similar in every respect to the massive ancient pavement uncovered two years before in the adjoining streets, and at the time described by me in my report to the department. Both of these Roman pavements connect, and the result is what more than two years ago I foretold would be found to be the case, viz., that a continuous Roman pavement would be found leading from the Judgment Hall of Pilate, in the Ecce Homo Convent, to the Damascus Gate, and through this to the place of execution (crucifixion) on the hill outside. This last discovered pavement runs from the Roman pavement of the Damascus Road street past the Turkish barracks and Ecce Homo Convent, as already mentioned, to the Tower of Antonio, and I have no doubt the feet of our Lord trod those stones on the way to his crucifixion and back and forth that terrible night before.

"Two years ago my personal investigation satisfied me that the present position of the Damascus Gate is that of the original gate. The fact of the two Roman pavements to which I have referred meeting there at an acute angle, when taken in connection with other points, settled that question for me. This is another justification of the assumptions of the sagacious Robinson. It is also a formidable obstacle to surmount in supposing the Church of the Holy Sepulchre to cover the place of the crucifixion and the tomb of Christ, who was certainly put to death without the gate and outside the walls.

"It is important to note that the recently found pavement opposite the convent is exactly on the level of the Roman pavement beneath that building and considered the Judgment Hall of Pilate, a further confirmation of its being the Gabbatha (John xix, 13).

"Of course, as in former instances, in constructing the sewer the Turks broke up the pavement; so it can never more be seen, having been almost completely destroyed. This, it is only proper to explain, was not done through any bigotry or spite, as, indeed, the Moslems consider Christ the greatest of prophets excepting Mohammed, but simply because the pavement was to them an obstruction which had to be removed. Still, we have preserved the stones made sacred by the feet of the Redeemer, and the flags saved will be used to pave part of the Ecce Homo Church."

A NEW EXPERIMENT.

To the Editor of Paving and Municipal Engineering:

SIR—The following report from Prof. Wm. B. Potter may be of interest to you:

C. O. Baxter, Esq.:

DEAR SIR—We have treated the seven Red Brick and the seven Treated Brick left with us as directed with the following results:

Weights of 7 Red Brick.....35.51 lbs.
Weights of 7 Treated Brick.....38.51 lbs.

This shows an increase in the Treated Brick of about 9 per cent. by weight.

One of each kind of bricks after weighing was left in water over night, and in the morning was found to have absorbed by weight the following amounts of water:

Red Brick .....9.48 per cent.
Treated Brick.....0.29 per cent.

A half brick of each kind was treated in a similar manner and found to have absorbed by weight the following amounts of water:

Red Brick .....7.23 per cent.
Treated Brick.....0.11 per cent.

Two Red and two Treated Bricks were tested for cross breaking and crushing strength, with the following results:

CROSS-BREAKING TESTS.

	Weights in lbs.	Broke at, in lbs.	F.
Red Brick	5.06	440	275
Red Brick	4.84	450	274
Treated Brick	5.53	1,150	719
Treated Brick	5.47	1,775	1,165

CRUSHING TESTS.

Half Brick Crushed Edgewise.

	Area in sq. in.	Broke at in lbs.	Strength per sq. in
Red Brick	9.37	44,000	4,700
Treated Brick	9.16	48,200	5,260
" "	8.52	45,000	5,280

In order to determine the durability to withstand abrasion, 2 half bricks of each class were tumbled in a revolving barrel and the amount of loss by abrasion was noted every 15 minutes. The barrel made 65 revolutions per minute.

	After 15 Min. Per cent.	After 30 Min. Per cent.	After 45 Min. Per cent.	After 60 Mins. Per cent.
Red Brick lost	4.40	6.78	10.75	11.45
" "	5.39	6.87	8.58	9.60
Treated Brick lost	2.58	4.29	5.62	6.64
" " "	3.37	4.97	6.01	6.58

From the above results it will be seen:

1. That the Red Brick absorbs a considerable amount of water, while the Treated Brick is practically unable to absorb any water.
2. That the Treated Bricks show a considerable increase in strength, both in the cross breaking and crushing tests.
3. That in the abrasion tests the Treated Bricks show a much greater durability, having an average loss of only about 62 per cent. of that of the Red Brick.

Respectfully,
ST. LOUIS SAMPLING AND TESTING WORKS.

The bricks used in this experiment were from one and the same lot of "hard-burned and red," made by the Hydraulic Press Brick Company, of St. Louis. Why wouldn't they make a good damp course when laid in a bituminous cement; ditto cheap laundry floors and sidewalks? Possibly they would be useful for many other purposes that I do not think of at present. The bricks were boiled in a Gilsonite compound for seven to eight hours, and compared with same quality "untreated."

C. O. BAXTER.

ST. LOUIS, MO., June 15, 1891.

PUBLICATIONS.

PAVEMENTS FOR SOUTHERN TOWNS. Illustrated. By A. C. Danver, Mobile, Ala.

This is a very hadsomely printed brochure, giving, in an interesting way, many facts about pavements for streets and walks, and is especially in the interest of wood block paving. It gives a number of fine views of improved streets in southern cities. The author is Mr. A. C. Danner, president of the Improved Wood Pavement Company, of Mobile, Alabama.

I. IRRIGATION DEVELOPMENT. History, Customs, Laws and Administrative Systems Relating to Irrigation and Water Courses in France, Italy and Spain. By Wm. Ham. Hall, State Engineer. Sacramento: State Printers.

II. IRRIGATION IN CALIFORNIA. The Field, Water Supply and Works in San Diego, San Bernardino and Los Angeles Counties. By Wm. Ham. Hall, State Engineer. Sacramento: State Printers.

These two volumes together form a partial report on Irrigation, which was submitted by Mr. Hall, as state engineer of California, two years ago, but which has only recently become available for general use, owing to the slow methods adopted with public documents. Irrigation is comparatively so new a practice in the United States that the part on Italian, French and Spanish systems is really an essential and valuable feature of the report. While some of our methods are new, for all precedents and for experience we must go back to Southern Europe, India or Mexico—perhaps to China, where irrigation has been practiced for many centuries, and where it probably originated. Mr. Hall has given a very full account, with numerous illustrations, of what has already been done in the three southern counties of California, and of what was proposed at the time he wrote. Some of these projects have since been carried out, while others still remain in abeyance.

Improvement and Contracting News.

PAVING.

York, Pa., favors brick paving.

Avondale, Ohio, will pave with brick.

Belding, Mich., is to have paved streets.

Davenport, Iowa, will pave with vitrified brick.

Tiffin street, Cleveland, O., will be paved with brick.

Youngstown, O., is paving her streets with brick.

Sharpsville, O., has decided to pave with cobble-stone.

Ludington, Mich., has a $10,000 improvement society.

Westerville, Ohio, will pave with burned brick this season.

Oakland, Cal., proposes to pave Twelfth street with bitumen.

Shreveport, La., wants street paving, and prefers vitrified brick.

Ogden, Utah, is still agitating the question of street paving.

Albany, Ind., talks of paving Grand street with granite blocks.

Kenton, O., has voted to spend $10,000 for street improvements.

Terre Haute, Ind., improved her streets $20,408.90 worth last year.

An enormous amount of street paving is being laid in Denver, Col.

Bay City, Mich., is still agitating the question of street paving.

Bedford, O., will pave several of her streets during the season.

Columbus, O., is paving a number of her streets with cedar blocks.

Reynoldsville, Pa., will pave Main street of that city in a short time.

Davenport, Ia., will macadamize a number of her streets this season.

Dunkirk, Ind., has passed resolution to pave Main street with brick.

Racine, Wis., wants State street of that city paved with cedar blocks.

Mifflingtown, Pa., has decided to macadamize Main street of that city.

Grand Rapids, Mich., is paving three of her principal streets with brick.

South Bend, Ind., proposes to pave Wayne street with cedar blocks.

Bids are desired for 10,000 square yards of brick paving at Roanoke, Va.

A large amount of asphalt pavement will be laid in Chicago this year.

Helena, Mont., will pave Main street, and favors granite or cedar blocks.

Hot Springs, Ark., will pave Central avenue, and favors vitrified brick.

Collinsville, Ia., has decided to pave Main street of that city with vitrified brick.

Evansville, Ind., will pave Eighth street with brick over a concrete foundation.

Helena, Mont., has finally decided to pave Main street of that city with wood.

St. Louis, Mo., proposes to spend $300,000 for street improvements during the season.

It has been decided to pave Second street, Memphis, Tenn., with vitrified brick.

Much street paving will be done at McKeesport, Pa. Macadamizing is favored by many.

Wilkes Barre, Pa. is discussing the question of paving a number of her streets with asphalt.

A Ludington, Mich., contractor named Reed will do $55,000 worth of paving for South Bend, Ind.

The firm of Wells & Co., Appleton, Wis., has been awarded a contract of $25,000 worth of street paving.

The city council of Alexander, Ala., have resolved to macadamize the streets of that city during this season.

Davis & Caldwell have secured a lot of paving in Sharon, Ohio. The amount of the contract is over $18,000.

The city clerk, Peoria, Ill, has been authorized to advertise for bids for the construction of asphalt pavements.

Topeka, Kan., will have several miles of new sidewalk this season. Most of the walks will be of vitrified brick.

The council committee on streets, Lansing, Mich., has been authorized to purchase two carloads of paving blocks.

Oakland, Cal., has appropriated the sum of $19,000 for the partial construction of the public boulevard around Lake Merritt.

Macadam pavement seems to be gaining in favor in Kansas City. Holmes street of that city will be macadamized soon.

A proposition to issue $30,000 to be expended for street paving will be submitted to the voters of Chillicothe, O., at an early date.

Findlay, Ohio, will pave Cherry street of that city with hard burned bricks, Halwood paving blocks, or Hayden paving blocks.

The city of Clinton, Iowa, has contracted for street paving to the amount of $165,000. It will require eight millions of brick to do the work.

Seventy-five thousand dollars will be spent this year by the city of Detroit, Mich., on cedar block paving, cobble-stone gutters and stone curbing.

Canton, Ill., proposes to build all her sidewalks in the future of brick, and also proposes to buy 50,000 paving brick per annum for at least ten years.

The Southern Pavement Co., of Fort Payne, Ala., is furnishing the compressed asphalt block for paving around the market house in Birmingham, Ala.

The board of public works, Duluth, Minn., has decided to pave West Fifth street a distance of about one mile and a half. It will cost in the neighborhood of $55,000.

The Rockford Construction Company, Rockford, Ill., has secured a contract for 100,000 yards of brick paving in Clinton, Iowa, and the total amount will reach nearly $150,000.

Sealed proposals will be received by the city clerk, in the town of Avondale, O., until July 25, for the improvement of Main street, paving the roadway with hard-burned or vitrified brick.

Sealed proposals will be received at the office of the city auditor of Dayton, O., until July 20, 1891, for paving Market street, Wayne avenue, North Main street and Washington street, of that city, with granite blocks, Medina blocks, Hayden blocks, Hallwood blocks, asphalt, red brick or fire brick. Specifications are on file at the office of city engineer.

SEWERS.

Williamsport, Pa.. will have sewers.

A sewer system is needed at Frankfort, Ind.

Rosebury, Ore., is to have a new sewerage system.

A number of sewers are projected at Gloversville, N. Y.

West Bay City, Mich., will spend $10,000 on sewers this year.

Findlay, O., is talking about establishing a new sewer system.

Ashtabula, O., has advertised for bids for a new sewer system.

Menominee, Mich., has let sewer contracts to the amount of $64,000.

Olympia, Wash., is agitating the question of a complete sewerage system.

North Yakima, Wash., is wrestling with the question of a sewerage system.

Ann Arbor, Mich., will be bonded in the sum of $20,000 for a sewerage system.

Manitowoc, Wis., is advertising for bids for the construction of nearly five miles of sewers.

The contract for the Eighth avenue sewer, Chicago, Ill., has been let, the price being $8,500.

John F. McMahon has been awarded the contract for the Armitage avenue sewer, Chicago, at $42,512.10.

The city council of Pontiac, Ill., have advertised for bids to construct a main sewer east and west to the river.

Sealed bids for a sewer over five miles in length will be received by the town clerk, Cicero, Ill., until July 17.

Proposals for the construction of a system of sewers will be received by G. W. Hackney, city clerk, Springfield, Mo.

A separate system of sewerage is to be built at Puyallup, Wash. Vitrified iron-stone pipe will be used. The cost is estimated at $45,265.

Mayor Holmes, Kansas City, Kan., has signed the O. K. creek sewer ordinance, and the contract will be advertised for at once. There remains $110,000 to be expended on it this season.

An ordinance providing for establishing a sewer district to be bounded by Thirty-first street, Turkey creek, Jefferson street, and the state line, will be introduced in the upper house at the next meeting of the Kansas City council. The district will contain about one hundred acres.

WATER-WORKS.

Hazen, Tenn., wants water-works.

Armour, Ia., will put in water-works.

Glenwood, Wis., is to have water-works.

Fowlerville has voted $40,000 for water-works.

Childress, Tex., is after a system of water-works.

Fowlerville, Mich., votes $40,000 for water-works.

Holland, Mich., will spend $14,000 on a water plant.

Armour, S. D., will put in a system of water-works.

Tracy, Minn., has voted $25,000 bonds for new city water-works.

Tomahawk, Wis., has voted to expend $16,000 on water-works at once.

De Laird, Fla., is making strenuous efforts for a system of water works.

Fort Worth, Tex., will spend $725,000 in public improvements and water-works.

It is quite certain now that Baird, Tex., will have water-works in the near future.

Savana, Ill., will spend $4,000 during the year on the extension of their water-works.

New Baltimore, O., has voted, by a large majority, to establish a water-works system.

Bids will be received until July 21, at Flanegan, Ill., for a system of water-works.

Plymouth, Mich., has voted to have water-works, not to cost more than $30,000.

Fredrick, Md., has advertised for proposals to erect a reservoir to hold 20,000,000 gallons of water.

St. Louis, Mo., is preparing to ask congress for a $12,000,000 appropriation for harbor improvements.

The contract for the construction of the Peru, Ill., water-works has been awarded to Sutphin & Co., of St. Louis, for $59,500.

Contract will be let July 29, at Madelia, Minn., for high tank and water mains, $9,000 to be expended on same. C. Cooley, recorder.

The village of Madelia, Minn., will let to the lowest bidder, July 29, 1891, a contract for high tank and water mains; $9,000 to be expended.

The board of trustees of the town of Brookville, Ind., have passed an ordinance providing for the construction of a reservoir system of water-works of one million gallons capacity daily. Contract will be let July 23, 1891. Address Clerk of Brookville.

City clerk of Moscow, Idaho, will receive sealed bids until July 27th, for the erection of a stand-pipe fourteen by eighty feet high, and for the extension of mains of the present water system of the city, consisting of 12,000 feet of six inch, and 7,000 feet of four inch pipe; also, twenty-three hydrants, and all fixtures to make the system complete.

BRIDGES.

Pope county, Ark., will build five new iron bridges soon.

The Winona, Minn., city council has decided to advertise for bids for building a new high bridge between Winona and the Wisconsin side of the Mississippi.

Depere, Wis., has voted $50,000 for the erection of an an iron bridge 1,500 feet long.

Three bridges will be erected over the Boise and Fayette rivers, at Boise City, Idaho.

A new bridge will be built at Twelfth street, across the Union Depot yards, at St. Louis, Mo.

The question of building a new bridge across the Missouri river at Leavenworth, Kan., is being agitated.

City council at Bonham, Texas, has decided to build an iron bridge across Powder creek at that place.

Kankakee, Ill., is agitating the question of a new bridge over the Kankakee, at the foot of West Court street.

Bids will be received until July 25 for an iron viaduct at Rock Island, Ill. Address Capt. M. W. Lyon.

Bonds to the amount of $90,000 will be issued for a new bridge north of North avenue, at Milwaukee, Wis.

Bay City, Mich., will construct a new bridge across the west channel of the Saginaw river at Twenty-third street.

Bids will be received until July 30th, for the building of a bridge fifty feet long, a combination of oak and iron, at Thurston, Neb.

St. Paul, Minn., is discussing the question of bonding the city in the sum of $75,000, for a combination railroad and wagon bridge.

An appropriation has been allowed for a new bridge on Twelfth street, St. Louis, Mo. Plans are already prepared for a $150,000 structure.

The contract for the steel bridge over the Tennessee river at Knoxville, Tenn., has been let to the Graten Bridge Company, Graten, N. Y.

Sealed proposals will be received until July 25 for a highway bridge and approaches thereto over the Mahoning river near the Lake Shore passenger station, Mahoning county, O. Address county auditor.

Crenshaw County (Ala.) Commissioners have ordered a new bridge over Big Patsaliga; one across Conecuh at Williams' Ford; the Peacock bridge across Conecuh, and the Summerlin bridge across Little Patsaliga

STREET RAILWAYS.

The Butte, Mon., Consolidated Railway Company has incorporated and will embrace all the street railroads of the city. Capital stock, $5,000,000.

An elevated road will soon be built in East Omaha running from 10th and Locust, in Omaha, to East Omaha, and eventually to Council Bluffs. J. R. Webster interested.

The Spokane and University Heights Street Railway Company have incorporated with a capital of $100,000. They will construct a street railway in Spokane Falls, Wash.

Motor *vs.* Horse.—Now at the end of sixty years, the capital invested in horse railroads is $58,000,000, and at the end of five years the capital invested in electric roads is $50,000,000.

The Inter-State Bridge and Street Railway Company has been incorporated in Omaha, Neb., with a capital of $2,500,000. Will construct a railway across the bridge over the Missouri river.

Electric railways will be constructed from Dawson to Juniata, Pa., at Mt. Holly, N. J., at Houston, Tex., from Jamestown to Lakewood, N. Y., at Bridgetown, N. J., Warren, Pa., Cumberland, Me., from Rochester, N. Y., to Charlotte and Manitau Beach, from Dennison, through Uhrichville to Edgeville, Ohio, at Kankakee, Ill., at Saccarappa, Me., from Brazil to Harmony, Ind., at Racine, Wis., between Carthage and Webb City, Mo., at Sullivan, Ill.; between Seattle and Tacoma, Wash.; at Columbia, S. C.; and between Burlington and Graham, N. C.

NIAGARA FALLS EXCURSION

Thursday, August 6, 1891.

VIA THE

Lake Erie & Western R. R.

"NATURAL GAS ROUTE."

On Thursday, August 6, 1891, the Lake Erie & Western R. R. will run their popular annual excursion to Cleveland, Chautauqua Lake, Buffalo and Niagara Falls at following very low rates, viz:

Peoria	$7 50	Ft. Wayne	$5 00
Bloomington	7 00	Muncie	5 00
La Fayette	6 00	Connersville	5 00
Michigan City	6 00	Rushville	5 00
Indianapolis	5 00	New Castle	5 00
Tipton	5 00	Cambridge City	5 00
Lima	4 00	Fremont	5 00

Sandusky, $4 00.

With corresponding reduction from intermediate points.

In addition to the above the purchasers of these tickets will be given privilege of special excursion side trips to Lewiston-on-the-Lake, including a steamboat ride on Lake Ontario, for 25 cents. To Toronto and return by Lake from Lewiston, $1.00; to Thousand Islands, $5 00. Tickets for the above side trips can be had when purchasing Niagara Falls ticket, or at any time on train.

Besides the above privileges, with that of spending Sunday at the Falls, we will furnish all those who desire, a side trip from Brocton Junction to Chautauqua Lake and return FREE OF CHARGE!

Tickets of admission to places of special interest at or near Niagara Falls, but outside the reservation, including toll over the International Bridge to the Canadian side, elevators to the water's edge at Whirlpool Rapids on the Canadian side, will be offered on train at a reduction from prices charged after reaching the Falls.

Do not miss this opportunity to spend Sunday at Niagara Falls. The excursion train will arrive at Niagara Falls 7:00 A. M., Friday, August 7, and will leave the Falls returning Sunday morning, August 9, at 6 o'clock, stopping at Cleveland Sunday afternoon, giving an opportunity to visit the magnificent monument of the late President Garfield, and many other interesting points.

Tickets will be good, however, to return on regular trains leaving the Falls Saturday, August 8, for those not desiring to remain over. Tickets will also be good returning on all regular trains up to and including Tuesday, August 11, 1891. *Secure your tickets, also Chair and Sleeping Car Accomodations,* early. Those desiring can secure accomodations in these cars while at the Falls. For further information call on any agent Lake Erie & Western R. R., or address C. F. DALY,

Gen. Pass. Agent, Indianapolis, Ind.

C. PARDEE TERRA COTTA WORKS,

PERTH, AMBOY, N. J.

JNO. H. WHITE, Mgr. ROBT. W. TAYLOR, Supt.

June 24, 1891.

Mr. Wm. Eudaley, Cincinnati, O.:

DEAR SIR: Mr. Calvin Pardee desires me to send you data showing our experience with your down-draft kilns which have been adopted in the new brick and floor tile works here.

The average time of firing is 135 hours, counting from the time of lighting the fires until the daubing up of the furnace doors.

The consumption of coal averages 12 7-8 tons per kiln, which contain 38,000 front brick, and sometimes as many five different kinds in one firing.

I forward a box of these to you showing their hardness, line and texture or toughness. This last quality we consider very essential, as masons experience difficulty and waste in cutting hard burnt brick if brittle. The clear color of the buff and gray brick is very gratifying, obtained as it is in the same firing with the old gold, speckled and purple brown brick of both Roman and Standard size fronts.

Illustrative of the uniform distribution of heat in your kiln, I can assure you that in the firing of the Roman brick, none of which are too pale or too hard, we have less than one-half per cent. broken or warped, while with the ordinary size fronts, both in stiff mud and dry press, the loss in chipped and bruised brick is less than four per cent., due partly to faulty setting, which we are overcoming.

The fuel we use is anthracite of broken size and bituminous coal (the proportion of each varied according to the extent of clear colored, or flashed face brick in the kiln).

These being the first of your kilns erected in this district the firemen had trouble at first with the throttle furnaces, but this difficulty is long overcome with the results as given above. I am, dear sir,

Yours truly, ROBT. W. TAYLOR,
Supt. Brick and Floor Tile Dept.

SEALED PROPOSALS.

PAVING.

Sealed proposals will be received at the office of the city auditor of the city of Dayton, until twelve o'clock, noon, Monday, July 20, 1891, for improving Wayne avenue, from the south line of Third street to the north line of fifth street, by constructing necessary foundations and making necessary excavation for same, furnishing and paving the roadway with granite block, Medina block, Hayden block, Hallwood block, asphalt, red brick or fire brick, or other material, furnishing and setting new curbs, redressing, rejoining and resetting old curbs, and furnishing and laying granite or Medina stone crossings and constructing the necessary culverts, drains, catch-basins and retaining walls, according to plans and specifications on file in the office of the city civil engineer. Estimated at 6,800 square yards of paving.

Bidders must indorse their names and the work bid for upon the outside of the envelope containing their bids.

Bidders to use the printed forms, as none other will be received.

Each bid must be accompanied by a deposit of $5,000 to be left in the hands of the city auditor as a guarantee of good faith on the part of the bidder.

The board reserves the right to reject any or all bids.

By direction of the board of city commissioners.
W. E. HOOVEN, President.
C. A. HERBIG, City Auditor.

PAVING.

Sealed proposals will be received at the office of the city auditor of the city of Dayton, until twelve o'clock, noon, Monday, July 20, 1891, for improving Market street, north and south of the city building, from Main street to Jefferson street, by constructing necessary foundations and making necessary excavation for same, furnishing and paving the roadway with granite block, Medina block, Hayden block, Hallwood block, asphalt block, red brick or fire brick, or other material, furnishing and setting new curbs, redressing, rejoining and resetting old curbs, according to plans and specifications on file in the office of the city civil engineer. Estimated at 1,700 square yards of paving.

Bidders must indorse their names and the work bid for upon the outside of the envelope containing their bids

Bidders to use the printed forms, as none other will be received.

Each bid must be accompanied by a deposit of $5,000 to be left in the hands of the city auditor as a guarantee of good faith on the part of the bidder.

The board reserves the right to reject any or all bids.

By direction of the board of city commissioners.
W. E. HOOVEN, President,
C. A. HERBIG, City Auditor.

PAVING.

Sealed proposals will be received at the office of the city auditor of the city of Dayton, until 12 o'clock noon, Monday, July 20, 1891. For improving North Main street from river bridge to north corporation line, by constructing necessary foundations and making necessary excavation for same, furnishing and paving the roadway between the street railroad tracks and curb line with Hayden block, Hallwood block, red brick or fire brick, furnishing and setting new curbs, redressing, rejoining and resetting old curbs and constructing the necessary culverts, drains, catch-basins and retaining walls, according to plans and specifications on file in the office of the city civil engineer. Estimated at 15,700 square yards of paving.

Bidders must indorse their names and the work bid for, upon the outside of the envelope containing their bids.

Bidders to use the printed forms, as none other will be received.

Each bid must be accompanied by a deposit of $5,000 to be left in the hands of the city auditor as a guarantee of good faith on the part of the bidder.

The board reserves the right to reject any or all bids.

By direction of the board of city commissioners.
W. E. HOOVEN, President.
C. A. HERBIG, City Auditor.

PAVING.

Sealed proposals will be received at the office of the city auditor of the city of Dayton, until 12 o'clock, noon, Monday, July 20, 1891, for improving Washington and Germantown streets, from west curb line of Ludlow street to west line of Broadway street, by constructing necessary foundations and making necessary excavation for same, furnishing and paving the roadway between the street railroad tracks and curb lines with Hayden block, Hallwood block, red brick or fire brick, furnishing and setting new curbs, redressing, rejoining and resetting old curbs and constructing the necessary culverts, drains, catch-basins and retaining walls, according to plans and specifications on file in the office of the city civil engineer. Estimated at 16,100 square yards of paving.

Bidders must indorse their names and the work bid for upon the outside of the envelope containing their bids.

Bidders to use the printed forms, as none other will be received.

Each bid must be accompanied by a deposit of $5,000 to be left in the hands of the city auditor as a guarantee of good faith on the part of the bidder.

The board reserves the right to reject any or all bids.

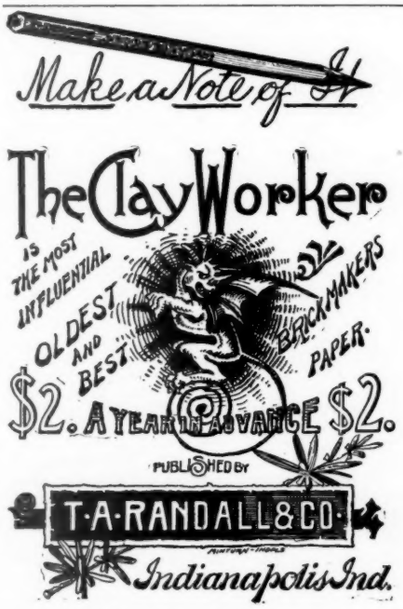
By direction of the board of city commissioners.
W. E. HOOVEN, President.
C. A. HERBIG, City Auditor.

NOTICE TO SEWER CONTRACTORS.

Sealed Proposals will be received by the Common Council of the city of Terre Haute, Ind., Tuesday evening, July 21, 1891, for the construction of about 4,400 feet of brick sewer, varying in size from 3'x4'6" to 2'4"x3'6"; and about 4,000 feet of pipe sewer, from 12" to 24" in diameter; 61 catch basins and 23 manholes.

Above amounts include two sewers to be bid on separately.

Plans and specifications on file in my office.
FRANK H. COOPER.
City Engineer.



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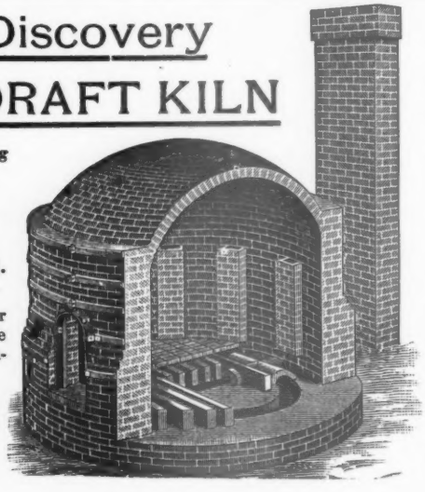

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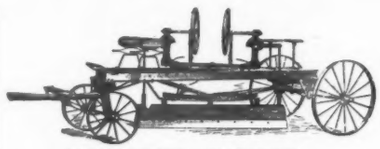

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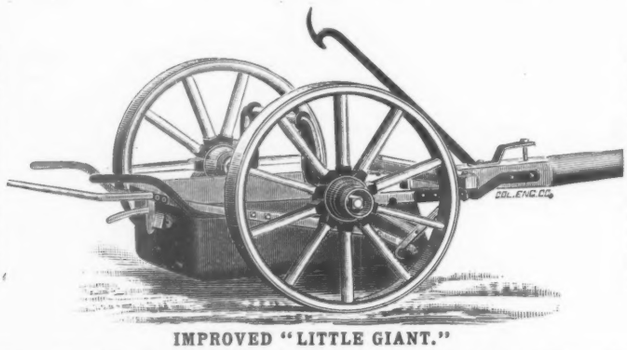

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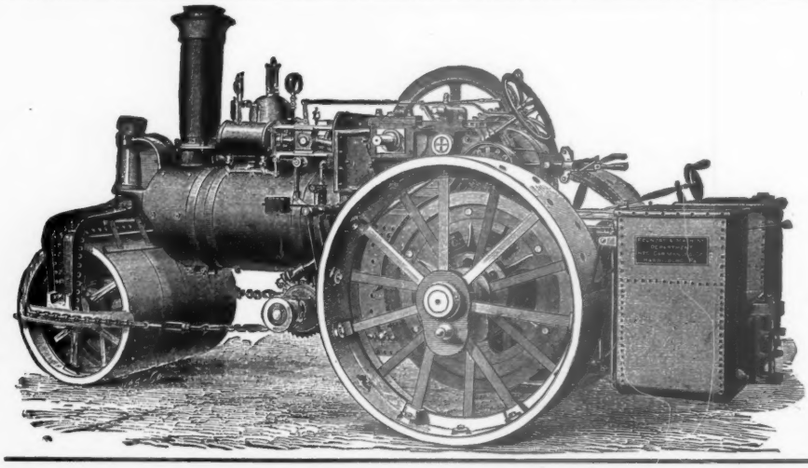

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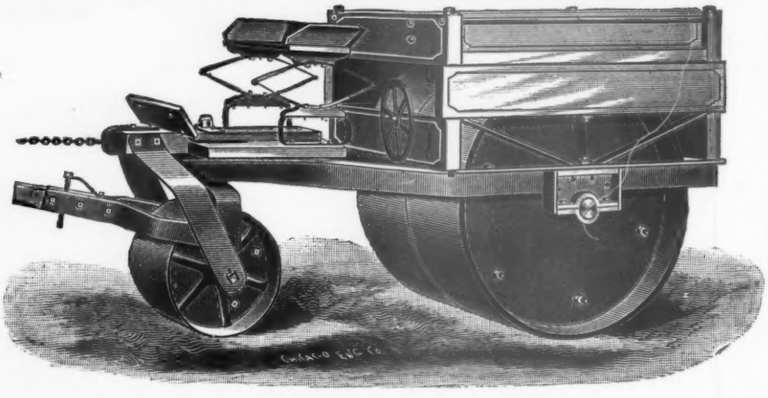

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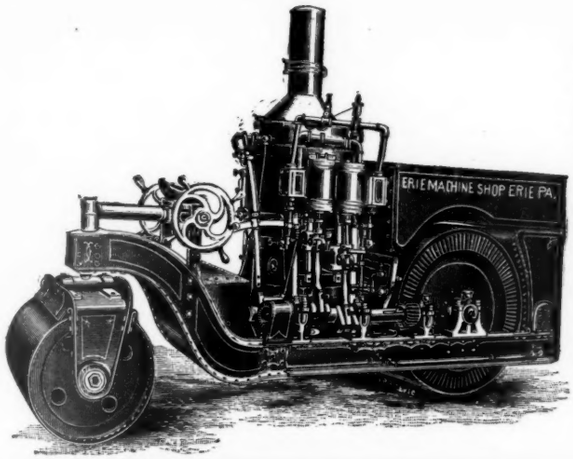

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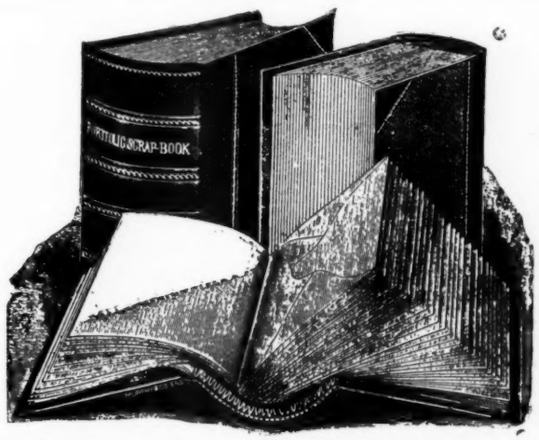

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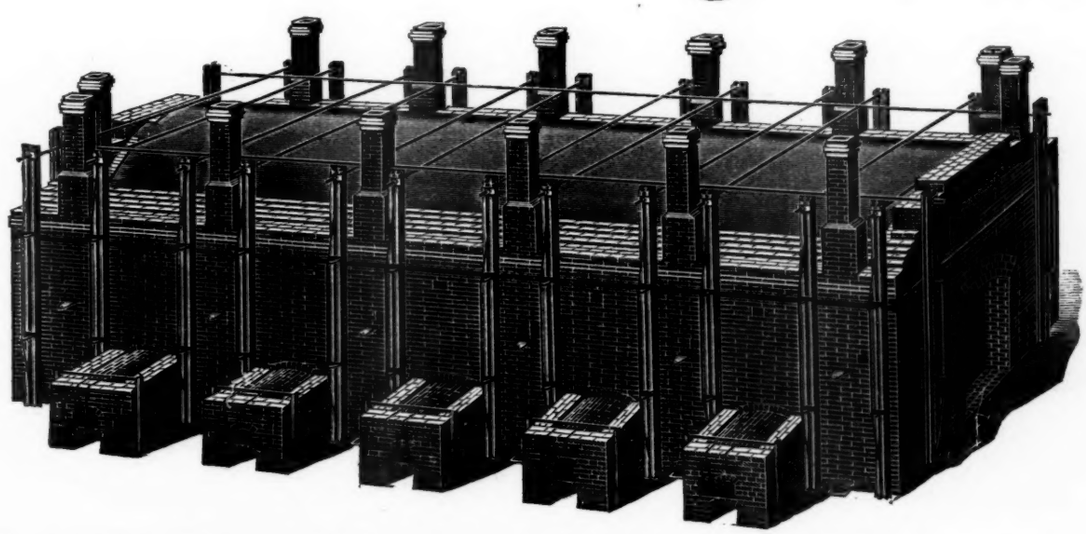

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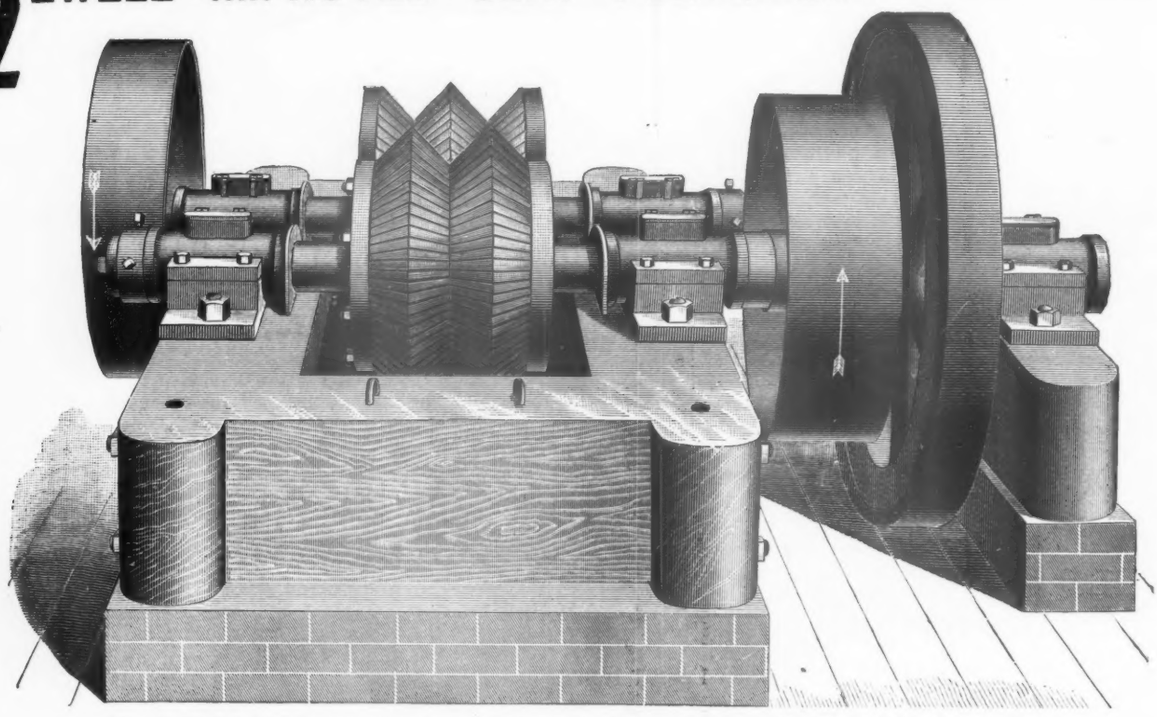

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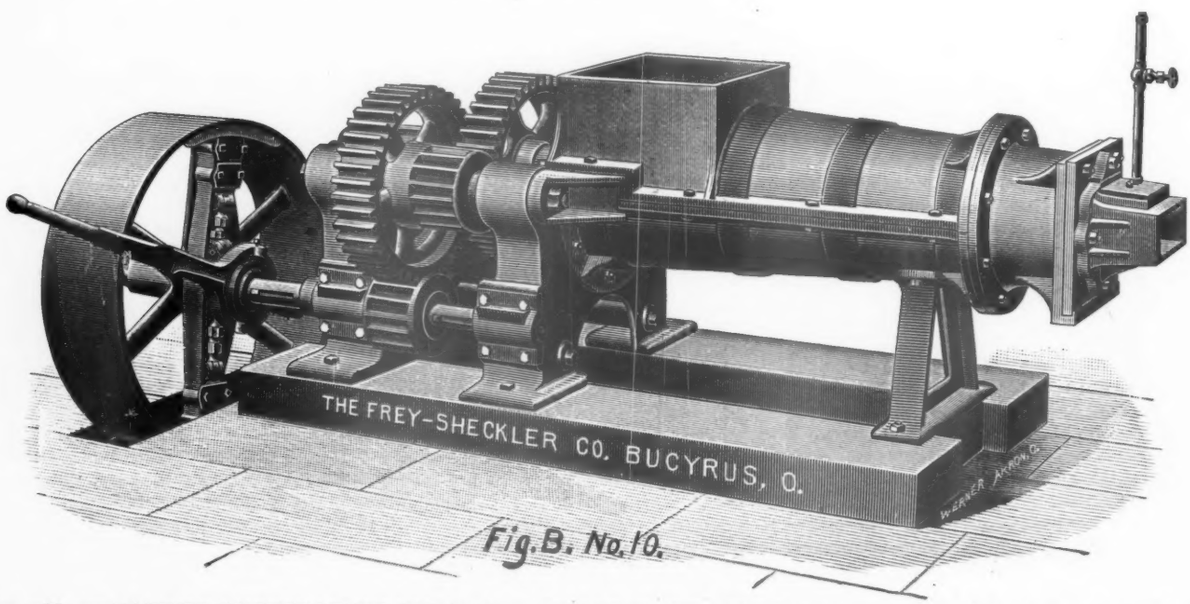

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Mr. D. V. Purington, of Chicago, the President of the Company, is one of the foremost brick makers in the country.

In less than ten years he has ordered and put into operation **ten Chambers Brick Machines,** and with this practical knowledge of their merits his Company at Galesburg uses

THE CHAMBERS BRICK MACHINES,
CHAMBERS HORIZONTAL PUG-MILL,
CHAMBERS WROUGHT BODY DRYER CARS.

IT PAYS TO BUY THE BEST. FOR ADVERTISEMENT CHAMBERS' MACHINERY, SEE LAST PAGE OF COVER.

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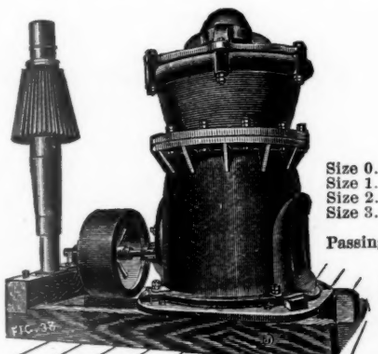
GATES ROCK AND ORE BREAKER



OVER **2000** IN USE.

CAPACITY IN TONS OF 2,000 POUNDS.

Size 0	2 to 4 tons per hour.	Size 4	15 to 30 tons per hour.
Size 1	4 to 8 tons per hour.	Size 5	25 to 40 tons per hour.
Size 2	6 to 12 tons per hour.	Size 6	30 to 60 tons per hour.
Size 3	10 to 20 tons per hour.	Size 7	40 to 75 tons per hour.
		Size 8	100 to 150 tons per hour.

Passing 2 1-2 in. ring, according to character and hardness of metal.

Great Saving in Power. Adjustable to any Degree of Fineness. The principle involved in this Breaker acknowledged to be the greatest success ever introduced into Stonebreaking machinery. The Gates Breaker has made more railroad ballast and road metal than all other kinds of breakers combined. **Universally Adopted by Mining Companies. Many Hundreds Used by Railway Companies.** Will furnish a thousand references from Contractors, Street Superintendents, Mines, Cement Manufacturers, etc. Also Manufacture

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Fine Crushing Plants, Concentrators and Other Mining Machinery. Address for Catalogue

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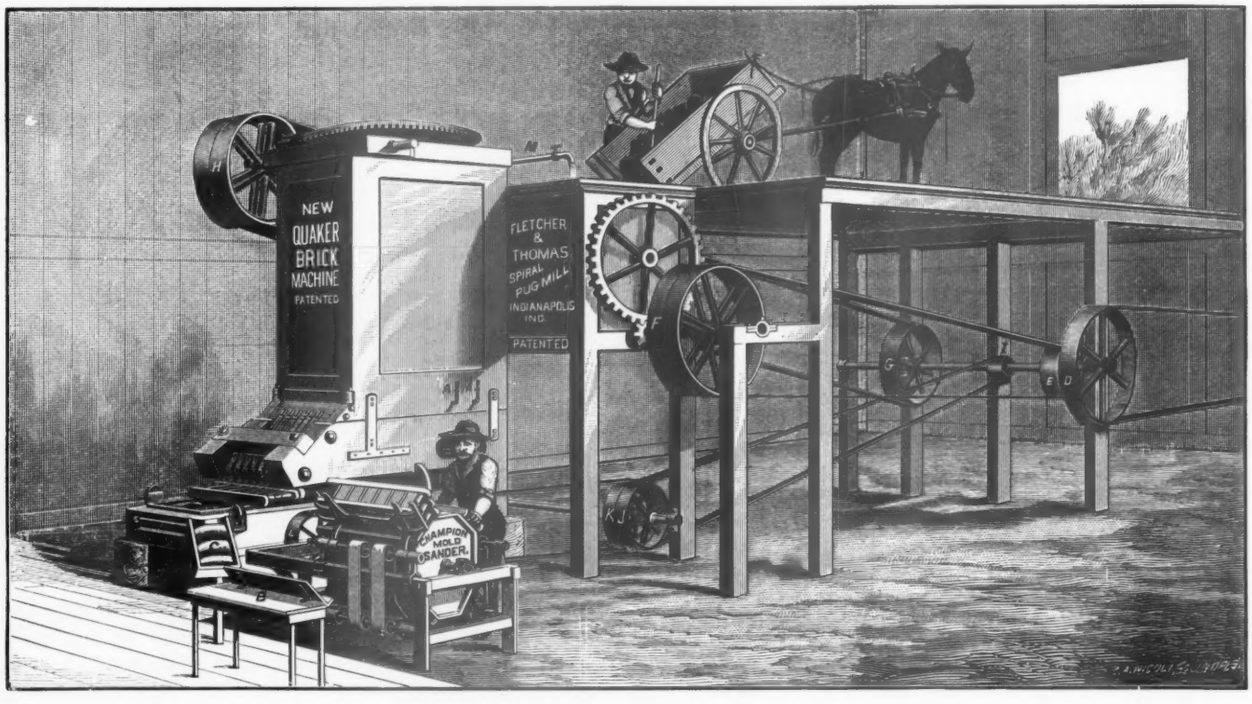

Improved Brick-Making Machinery

The above cut represents the New Quaker Complete Combined Steam Power Outfit. Capacity, 40,000 per day. Capacity of Horse-Power, 15,000 to 20,000. The most perfect machinery for making PAVING BRICKS, FIRE BRICKS or COMMON BRICKS. We make a specialty of equipping yards complete in every detail ready for work. Send for illustrated catalogue.

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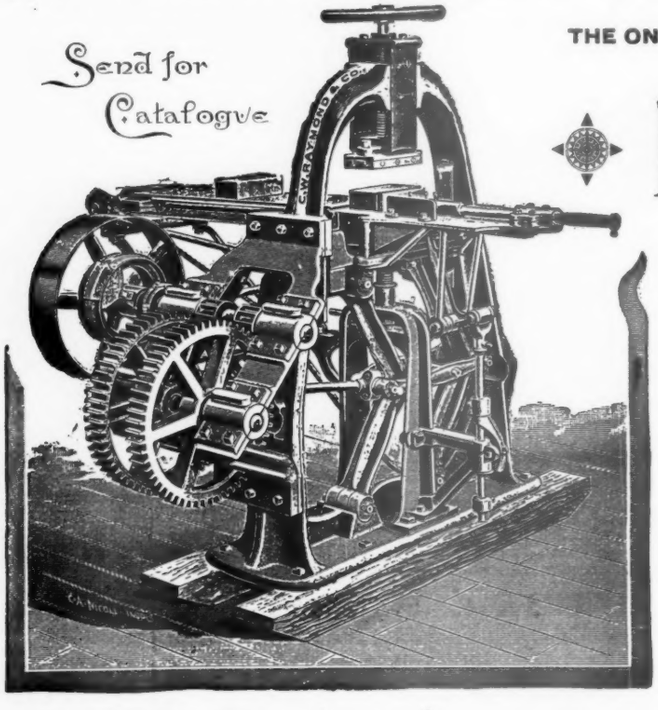

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RED AND FIRE BRICK, ROOFING TILE, ETC.

A rapid working and powerful machine for pressing paving blocks, by which they are given great density and uniformity of size and finish. Make from 8 to 12 thousand finished paving blocks per day. No first-class paving brick made without re-pressing.

Dumping Cars, Portable Track,
Dryer Cars, Transfer Cars
and General Brick Yard Supplies.

C. W. Raymond & Co., Dayton, Ohio.

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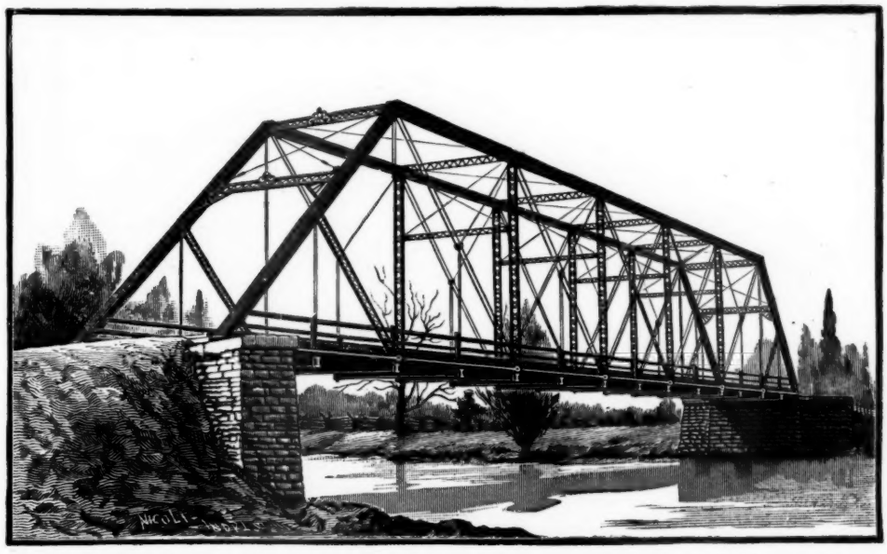

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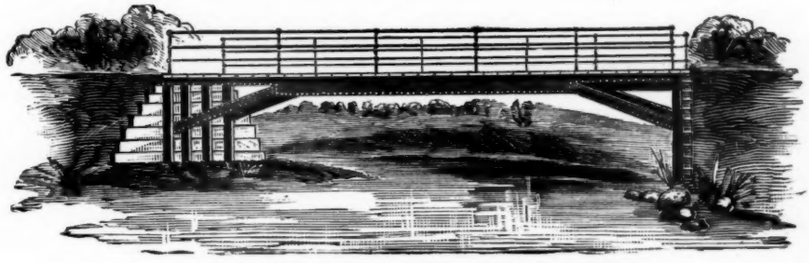

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ABOVE CUT SHOWS OUR PATENT LEG BRIDGE.

OVER TWO HUNDRED IN USE IN THIS STATE.

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The demand for these Celebrated Brick has hitherto far exceeded the supply. By the erection of one of the largest and most complete plants in the country, the PURINGTON PAVING BRICK COMPANY expects to be able to furnish these Brick in any desired quantity, and to fill all orders promptly and satisfactorily. ∴ ∴ ∴ ∴ ∴ ∴ ∴

Prices and samples furnished on application to

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THESE BRICK are gaining a national reputation for toughness, and resistance to abrasion and the action of frost. LONDON PAVING BRICK have won the laurels in many severe tests, and to-day stand at the head of the list of vitrified paving brick in this country.

Our capacity and shipping facilities are such as to enable us to fill orders promptly. Contractors should make a note of this when wanting large quantities.

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THE STANDARD ASPHALT COMPANY, of Bakersfield, Kern Co., California, controlling extensive deposits of genuine asphaltum, believed to be second only to the Trinidad in extent, invite orders for high grade refined asphalt for street paving and other purposes. The supply being practically unlimited, there is no ground for fear that the large and increasing demand can not be met for many generations, notwithstanding those who control the imported article give currency to the idea that there is none in the United States. Our asphalt is fluxed, softened and refined with a natural maltha (liquid asphalt) of 10° to 14° Baumé, forming a chemical and homogeneous mixture superior to the residuums elsewhere used. We can furnish fluxing maltha with our asphalt for the manufacture of paving cement, when desired. We also manufacture the Standard Asphalt Roofing Compound, covered by U. S. and foreign letters patent, flexible, elastic and durable, confidently asserted to be superior to any asphalt pitch or tar roofing ever used. The Standard Asphalt is likewise adapted to and used for pipe covering, electric conduits, reservoir linings, varnishes, etc.

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FOR STREETS, ALLEYS, SIDEWALKS, ETC.
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FIRE BRICK, FIRE CLAY, ETC.

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No Coal-tar Product.

Absolutely Free from Sediment.

FOR INTERSTITIAL FILLING
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Over five million square yards in use in the United States.

It has, in fifteen years, raised the streets of Washington and Buffalo from the poorest to the best in the United States.

It will raise the streets of any city that uses it to the same high grade.

It is the only pavement that will do it.

It is the only perfect sanitary pavement.

It enhances the value of abutting property as much as it improves the city using it.

It is the ideal pavement of modern times.

We invite an inspection of our work.

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THE BEST PAVING MATERIAL

The sapless paving blocks made by us make the best and most economical pavement before the public to-day. We can prove it by hundreds of testimonials. Blocks furnished by the car load anywhere. Our second quality blocks are the best and cheapest for repairing block pavements, or for a substantial floor in warehouses and the paving of private alleys and driveways. Ask for prices.

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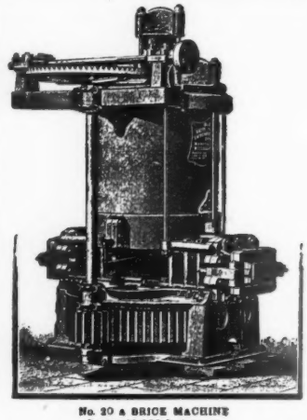
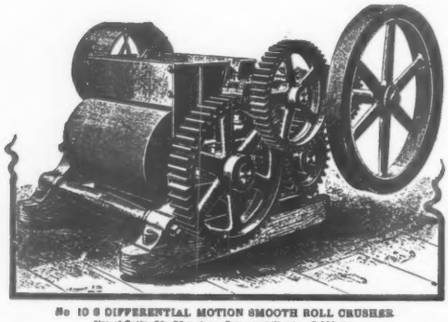
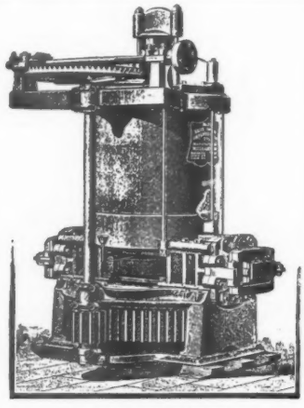
BRICK AND TILE MACHINES OF ALL SIZES AND CAPACITIES.



No. 20 a BRICK MACHINE
Capacity, 60,000 Brick per day

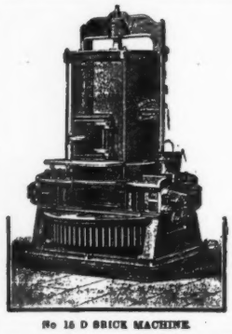


No. 10 S DIFFERENTIAL MOTION SMOOTH ROLL CRUSHER
Size of Rolls, 24 x 36 Inches. Estimated Weight, 12,000 lbs.



No. 20 B BRICK MACHINE

OUTFITS FOR MAKING PAVING BRICK, FIRE PROOFING AND TERRA COTTA. LUMBER A SPECIALTY

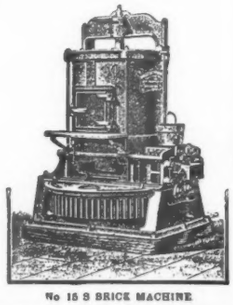


No. 15 D BRICK MACHINE

No. 7 SPECIAL BRICK MACHINE

No. 3 E HORSE-POWER BRICK MACHINE

No. 6 SPECIAL TILE MACHINE



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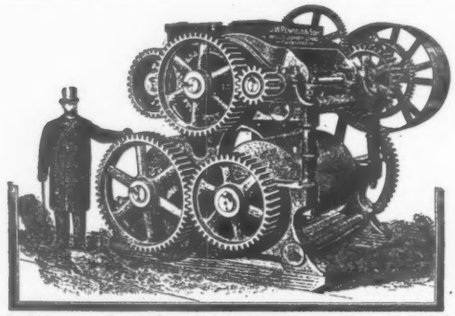
Cast Rings and Covers for Crowned Kilns

Combined Kiln and Ash Doors



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With Patent Automatic Feeder

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